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DETERMINANTS AND IMPLICATIONS OF PHYSICAL ACTIVITY IN HIP AND KNEE OSTEOARTHRITIS: AN INTEGRATED APPROACH

BY

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Abstract

This thesis aimed to advance the understanding regarding physical activity (PA) determinants in hip and knee osteoarthritis. A systematic review of qualitative evidence on PA barriers and facilitators revealed a complex interplay among physical, psychological, social and environmental factors. Next, a quantitative study assessed key factors from each category and accelerometer-measured PA. PA intensity/sedentary time (ST) classification was examined for age-relevant and commonly used cut points. The comparison yielded significant differences between the cut points for time spent in PA intensities/ST and for people meeting moderate-to-vigorous-PA(MVPA) guidelines, but had limited implications for MVPA (bouted, total) associations with health and well-being. Drawing from Social-Cognitive and Ecological Theories of behaviour, an integrated path model of self-efficacy and neighbourhood facilities predicting MVPA (bouted, total) and in turn physical function and quality of life was tested. The model showed a good fit for bouts, but not total MVPA. Lastly, a qualitative inquiry into peoples' daily PA and sedentary experiences revealed that these were multifaceted and PA/sedentary behaviours were the outcome of a dynamic negotiation between the burden of osteoarthritis, the need to keep mobile/enjoying life, and life context. Overall the findings suggest potential PA determinants to target and outcomes to consider in future interventions.

Dedicated to my parents, George and Despoina Kanavaki,
and my aunts, Maria and Annie Plevraki

List of publications

During the Ph.D. the following pieces of work have been submitted for publication:

- Kanavaki, A.M., Rushton, A., Efstathiou, N., Alrushud, A., Klocke, R., Abhishek, A., Duda, J.L (2017). Barriers and facilitators of physical activity in knee and hip osteoarthritis: a systematic review of qualitative evidence. *BMJ Open*, 7(12)

The above paper is included in the thesis as Chapter 3.

Contributions. Study concept and design: JLD, AR, AMK, RK, AbA, NE. Searches: AMK, AsA. Study appraisal: AMK, NE. Data analysis: AMK, checked by NE. Data interpretation: AMK, checked by JLD, AR, NE. Manuscript draft: AMK. Manuscript review and input: JLD, AR, NE, RK, AbA. All authors approved the final draft.

- Alrushud, A., Rushon, A., Kanavaki, AM, Greig, C. (2017). Effect of physical activity and dietary restriction interventions on weight loss and the musculoskeletal function of overweight and obese older adults with knee osteoarthritis: a systematic review and mixed method data synthesis. *BMJ Open*, 7(6)

The above work is not part of the thesis.

- Kanavaki, A.M., Rushton, A., Klocke, R., Abhishek, A., Duda, J.L. (2016). Barriers and facilitators to physical activity in people with hip or knee osteoarthritis: Protocol for a systematic review of qualitative evidence. *BMJ Open*, 6(11)

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Table of contents

Abstract	ii
List of publications	iv
Acknowledgements	v
Table of contents	vi
List of Figures	xiv
List of Tables	xv
List of Appendices	xvi
List of abbreviations	xvii
CHAPTER 1.....	1
INTRODUCTION	1
Aetiology of OA	4
Prevalence of OA.....	7
Living With Hip or Knee OA: Health And Psychological Distress	7
Physical Activity as a Treatment Option for Hip and Knee OA	9
How active are people living with hip and knee OA?	18
Promoting a physically active lifestyle in hip and knee OA: challenges and gaps	19
Behavioural change theories: identifying physical activity determinants	21
Overview of published systematic reviews on PA determinants in hip and knee OA.....	24
Thesis aims.....	25
Thesis outline	27
CHAPTER 2.....	29
BARRIERS AND FACILITATORS TO PHYSICAL ACTIVITY IN PEOPLE WITH HIP OR KNEE OSTEOARTHRITIS: PROTOCOL FOR A SYSTEMATIC REVIEW OF QUALITATIVE EVIDENCE.	29
ABSTRACT	30
Strengths and limitations:	31

Introduction	32
Objective	34
Methods	34
Eligibility criteria	35
Information sources	36
Search.....	36
Study records.....	37
Data items	38
Outcomes and prioritisation	38
Appraisal of study quality	38
Data synthesis	40
Confidence in the synthesised qualitative findings	41
Discussion	41
Acknowledgments	42
Footnotes.....	42
CHAPTER 3.....	43
BARRIERS AND FACILITATORS OF PHYSICAL ACTIVITY IN KNEE AND HIP OSTEOARTHRITIS. A SYSTEMATIC REVIEW OF QUALITATIVE EVIDENCE	43
Abstract	45
Strengths and limitations of this study.....	46
Introduction	47
Methods	48
Eligibility criteria	48
Information sources	49
Search.....	49

Study selection.....	50
Data collection and appraisal.....	50
Synthesis of results.....	51
Additional analysis.....	51
Results.....	52
Study selection.....	52
Study characteristics.....	53
Appraisal of studies.....	53
Synthesis of results.....	53
1. Physical health.....	60
2. Intrapersonal/ psychological factors.....	61
3a. Social Environment	65
3b. Physical Environment	67
Discussion	67
Amendments to the protocol.....	72
Footnotes.....	73
Epilogue	74
CHAPTER 4.....	78
METHODS FOR A CROSS-SECTIONAL, QUANTITATIVE STUDY ON PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR CORRELATES IN HIP AND KNEE OSTEOARTHRITIS.....	78
Ethics approval.....	79
Setting and procedures	79
Participants.....	81
Measures	81

Objective measures	84
Self-reported measures	86
Sample size.....	92
CHAPTER 5.....	93
LEVELS AND CORRELATES OF ACCELEROMETER-ASSESSED PHYSICAL ACTIVITY AND SEDENTARY TIME: IMPLICATIONS OF DIFFERENT CUT POINTS IN PHYSICAL ACTIVITY CLASSIFICATION FOR HEALTH AND WELL-BEING.....	93
Introduction	94
Study aims.....	98
Methods	99
Research design and setting	99
Participants.....	100
Measures	100
Data analysis.....	102
Results.....	105
Participants' characteristics	105
Physical activity and sedentary time assessment	108
PA level and ST comparisons between the two sets of cut points (Aims 1a and 2)	108
Meeting MVPA guidelines (Aim 1b)	109
MVPA pattern correlations with health and well-being outcomes and comparison of correlation coefficients between cut points (Aim 3)	109
Total MVPA.....	109
Bouted MVPA.....	113
Discussion	113

Sample characterisation	114
What can MVPA patterns tell us about health and well-being in lower limb OA?	115
Implications for research and clinical practice	117
Strengths and limitations	118
Conclusion	118
CHAPTER 6.....	120
PSYCHOLOGICAL AND ENVIRONMENTAL PREDICTORS OF MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY, PHYSICAL FUNCTION AND QUALITY OF LIFE IN LOWER LIMB OSTEOARTHRITIS: ASSESSING A PATH MODEL FOR DIFFERENT PATTERNS OF PHYSICAL ACTIVITY ACCUMULATION	120
Study aims.....	124
Methods	125
Outcome Measures.....	126
Self-efficacy	126
Facilities distance	126
Objectively measured physical activity.....	126
Physical function	127
Physical and Psychological Quality of Life	127
Demographic and disease related characteristics.	127
Statistical analyses	128
Results.....	129
Participant characteristics	129
Bivariate correlations	130
Path analysis.....	133

Discussion	137
Implications of the integrated model of MVPA correlates	137
MVPA as more than one behavioural pattern	139
Strengths and limitations	140
CHAPTER 7.....	144
PHYSICAL ACTIVITY AND SEDENTARY EXPERIENCES IN PEOPLE LIVING WITH HIP AND KNEE OSTEOARTHRITIS: A BALANCE BETWEEN BEING CONSTRAINED AND TO KEEP ENJOYING LIFE	144
Introduction	145
Study aims.....	148
Methods	148
Ethics	148
Study Design	149
Participant Selection	149
Settings and Procedures	149
Data Analysis	151
Trustworthiness.....	152
Findings	155
Physical Activity Negotiations	155
Valuing mobility: from preservation to life enjoyment (12).....	157
The burden of osteoarthritis (12).....	158
Keep going (12).....	167
The feel-good factor (11)	172
Sedentary Behaviour Negotiations	174
The joy of sitting (12).....	174

A lot is too bad (9).....	175
The osteoarthritis confines (8).....	177
Overlapping Themes between “Physical Activity Negotiations” and “Sedentary Negotiations”	178
The life context (12).....	178
Finding a Balance (11)	182
Discussion	183
Strengths and limitations	187
Implications for research and clinical practice	188
Conclusion	189
CHAPTER 8.....	190
GENERAL DISCUSSION.....	190
Chapter 3: A systematic review of qualitative evidence on PA barriers and facilitators	192
Chapter 5: MVPA levels and correlates for different PA classification cut points	194
Chapter 6: psychological and environmental predictors of MVPA, physical function and quality of life- an integrated model.....	195
Chapter 7: experiences of physical activity and sedentary behaviours in hip and knee osteoarthritis.....	197
Novelty and insights.....	199
Limitations.....	202
Sampling.....	202
Confounding factors and sub-group analysis	203

Implications for future research and promotion of an active lifestyle in hip and knee OA.....	203
Accelerometer-assessed PA	203
Multivariate and multilevel research of PA determinants.....	204
Implications for health-care	206
Conclusion	209
References.....	212

List of Figures

Figure 1.1	Knee OA progression illustrated by x-ray	2
Figure 1.2	Illustration of biomolecular agents in OA	6
Figure 1.3	Moderate PA as a means of prevention of OA progression.....	16
Figure 3.1	Study selection PRISMA flow diagram	52
Figure 3.2	Study selection PRISMA flow diagram- update.....	75
Figure 4.1	Summary of the systematic review findings (chapter 3)	82
Figure 4.2	Summary of physical activity and sedentary time correlates assessed in the quantitative study	83
Figure 5.1	Participant Recruitment Flow Diagram	100
Figure 6.1	Hypothesised model of MVPA.....	125
Figure 6.2	Modified path model for daily minutes of total MVPA (poor fit).....	134
Figure 6.3	Modified path model for daily bouted MVPA (good fit)	136
Figure 7.1	A visual representation of the overarching and main themes	156

List of Tables

Table 3.1 Study characteristics.....	56
Table 3.2 Appraisal of studies	57
Table 3.3 Barriers and facilitators: Themes, subthemes and number of supporting references.....	59
Table 3.4 Study characteristics for eligible studies published between 01/2016- 07/2019	76
Table 5.1. Descriptive statistics for the study outcome measures	106
Table 5.2. Descriptive statistics for physical activity levels and sedentary time.....	110
Table 5.3. Proportion of participants meeting the 150 min/week MVPA recommendations	110
Table 5.4. Bouted and total MVPA correlations with health and well-being outcomes and comparisons of correlation coefficients between cut points.....	111
Table 6.1. Descriptive statistics of the study variables (continuous).....	131
Table 6.2. Internal reliability and bivariate correlations amongst variables in the hypothesised models.	132
Table 7.1. Participants demographic, OA-related, physical activity and sedentary time characteristics	154

List of Appendices

Appendix 1.....	274
Appendix 2.....	275
Appendix 3.....	283
Appendix 4.....	296
Appendix 5.....	340
Appendix 6.....	342

List of abbreviations

BMI= body mass index

LPA=light physical activity

MPA= moderate physical activity

MVPA= moderate-to-vigorous physical activity

OA= osteoarthritis

PA= physical activity

QoL= quality of life

SB= sedentary behaviour

SCT= Social-Cognitive Theory

SDT= Self-Determination Theory

SE= self-efficacy

ST= sedentary time

VPA= vigorous physical activity

CHAPTER 1

INTRODUCTION

Osteoarthritis (OA) is one of the leading causes of disability and pain worldwide (Bartley et al., 2017; Cross et al., 2014). Hip and knee OA are characterised by pain, stiffness, swelling, impaired joint functioning and radiographically by bone changes such as osteophytes, subchondral sclerosis, subchondral cysts and joint space narrowing (Griffin and Guilak, 2005; Kijowski et al., 2006). Figure 1.1 shows an example of radiographic knee OA progression.



Figure 1.1 Knee OA progression illustrated by x-ray

The x-ray depicts from doubtful joint space narrowing (grade 1) to mark joint space narrowing and bone deformity, large osteophytes and severe sclerosis (grade 4). Grades represent the commonly used Kellgren and Lawrence OA classification system. Adapted from Ryu and colleagues (Ryu et al., 2012).

Clinical and radiographic findings do not necessarily coexist and the presence of either symptoms or a combination of symptoms and signs lead to an OA diagnosis (Hannan et al., 2000; Prasad et al., 2013). Importantly, OA is not only about tissue degeneration: the whole joint as a functional unit is affected including the periarticular muscles (Hurley, 1999;

Szychlińska et al., 2016). Knee and hip OA have slow progression with regard to radiographic findings (Passey et al., 2015; Soni et al., 2012), symptoms and physical function (Oiestad et al., 2016; Van Dijk et al., 2006), although symptoms and disease progression show great variability among individuals. Due to the variability in aetiology, experienced symptoms and disease progression, OA has been characterised as a condition consisting of different phenotypes, that is, one or a constellation of disease characteristics that relate to different outcomes (Driban et al., 2010). Currently, there is not a single widely accepted phenotype classification, but classifications based on multiple patient characteristics (pain sensitisation, mental distress, radiographic findings, muscle strength, body mass index (BMI) and comorbidities) appear to be related to clinically distinct phenotypes (Deveza et al., 2017).

Hip and knee OA greatly affect individuals' physical and mental health and also constitute a socio-economic burden (Litwic et al., 2013). Pain, physical limitations and deconditioning, psychological distress and intrapersonal difficulties, fatigue, sleep disturbance, as well as financial hardship are all aspects of the OA burden on the individual (Busija et al., 2013). Acknowledging the impact of OA on both physical health and well-being, the Arthritis Research UK report (ARUK, 2013) states that the physical and mental health needs of OA patients should be sufficiently met and means of physical exercise promotion and mental health support should be in place. The direct (medical) and indirect (productivity loss, disability benefits) costs of hip and knee OA are high (Bitton, 2009; Chen et al., 2012). Evidence regarding the estimated economic cost of OA in the UK suggests costs of £44.85 million for pharmacological treatment and more than £850 million for hip and knee joint replacements, plus productivity loss costing over £3.2 billion (Chen et al., 2012).

The sections that follow present the aetiology and prevalence of hip and knee OA, its effects on physical and mental health and the importance of a physically active lifestyle in hip

and knee OA management. Next, the low physical activity (PA) levels reported in this population in combination with the limited effectiveness of existing interventions in changing PA behaviour will be focused upon. Lastly, the aims of this thesis are illustrated, namely, an in-depth inquiry on PA determinants in patients with hip and knee OA.

Aetiology of OA

OA has been described as a disease of mechanics (Felson, 2013), as well as an inflammatory disease (Berenbaum, 2013). The aetiology of OA is complex and related to a sequence and interaction between mechanical and biochemical processes. The risk factors for hip and knee OA, namely, older age, female gender, obesity, muscle weakness, history of joint injuries and surgery, occupational overuse, existing joint abnormalities (ARUK, 2012), with the potential exception of female gender, are linked to mechanical and biochemical effects on the joint.

In a healthy synovial joint, articular cartilage ensures a low-friction transmission and distribution of load by a viscoelastic creep and stress relaxation response to compressive forces (Fox et al., 2009). Cartilage consists of specialised cells, the chondrocytes, and an extracellular matrix. The extracellular matrix is produced by the chondrocytes and consists primarily of water and the two main load-bearing macromolecules, collagen and proteoglycans (Fox et al., 2009). Articular cartilage receives its nutrients from the surrounding synovial fluid, as it contains no blood vessels, lymphatics or nerves. As a result, its capacity for self-repair following injury and age-related degeneration is limited (Buckwalter and Mankin, 1998; Musumeci et al., 2014a). The extracellular matrix maintains a homeostatic balance with regard to degradation and replacement of its various macromolecules, a process which is linked to chemical and mechanical cues (Fox et al., 2009). Moderate mechanical joint

loading and movement are therefore essential for the maintenance of cartilage metabolism (Griffin and Guilak, 2005).

Joint structure, composition and metabolism are altered in a joint with OA in comparison to a healthy joint and play a critical role in OA progression (Guilak et al., 2004; Setton et al., 1999). Acute (injury) or chronic high mechanical loading, including meniscal tear at younger or middle age and anatomic hip and knee abnormalities, such as varus knee or hip femoroacetabular impingement lead to cartilage degeneration (Felson, 2013; Griffin and Guilak, 2005). Such mechanical factors initiate a release of pro-inflammatory cytokines, which take part in further cartilage matrix degeneration, involving synovitis (synovial membrane inflammation) and age-related inflammation (Griffin and Guilak, 2005; Scanzello and Goldring, 2012; Szychlińska et al., 2016). A review of studies applying a magnetic resonance technique commonly used as a non-invasive biomarker for OA, identified loss of proteoglycan, degradation of collagen network and water increase in articular cartilage and menisci as early OA changes (Baum et al., 2013). The latter features predict further structural cartilage, menisci and bone marrow degeneration (Baum et al., 2013). Structural and biochemical changes in the osteoarthritic joint are further supported by studies applying invasive methods such as histology and immunohistochemistry. For example, Musumeci and colleagues found structural changes in menisci microanatomy and reduced chondroprotective glycoproteins (lubricin in particular) in OA patients in comparison to healthy controls (Musumeci et al., 2014b). Figure 1.2 is an illustration of the biomolecular agents involved in joint degeneration in OA.

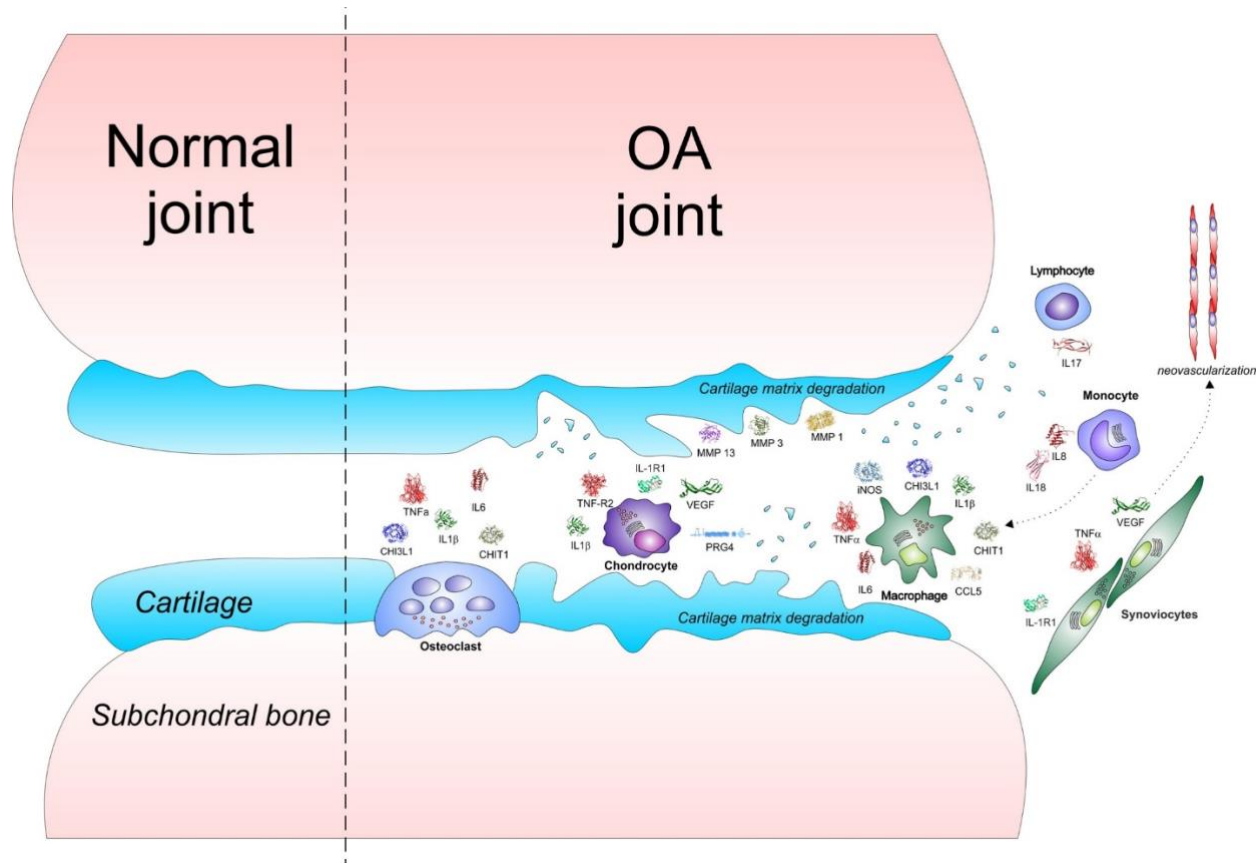


Figure 1.2 Illustration of biomolecular agents in OA

The figure depicts pro-inflammatory cytokines and various types of cells, involved in joint degeneration in OA in comparison to a normal joint. Reproduced with permission from Szychlińska et al. (2016).

Obesity and ageing increase the risk of accelerated development of hip and knee OA. Both obesity and ageing are related to biomechanical joint alterations (Runhaar et al., 2015; Vinatier and Guicheux, 2016). Several multilevel mechanisms are involved in this process including joint overload and obesity-related inflammation (Wang et al., 2015), ‘inflammaging’ (low-level chronic inflammation manifested with aging) (Franceschi and

Campisi, 2014) and muscle senescence (i.e., weakening of the muscles manifested with aging) (Felson et al., 2000).

Prevalence of OA

The estimated prevalence of hip and knee OA varies according to the definition of OA (e.g., symptomatic, radiographic) and the study population (Zhang and Jordan, 2010). Overall hip and knee OA are common conditions especially in older adults. Based on data from the Johnston County Osteoarthritis Project, a large longitudinal population-based study in the US, Murphy and colleagues reported that the life time risk for developing OA is almost one in two people for knee OA (Murphy et al., 2008) and one in four for hip OA (Murphy et al., 2010).

A recent systematic review specified the prevalence of patellofemoral OA only, to be 39% in populations with knee pain and aged 30 years or older (Kobayashi et al., 2016). Between 1998 and 2008 there was an increase of 30% in the OA population in the US (Lawrence et al., 2008; Lawrence et al., 1998). These numbers are expected to rise, even double, over the next decades due to the increase in sedentary lifestyles, obesity rates and life expectancy (Arthritis Alliance, 2011; Zhang and Jordan, 2010).

Living With Hip or Knee OA: Health And Psychological Distress

Living with hip or knee OA means living with pain. Pain from OA has been described as a constant ache or episodic severe pain, the latter being experienced as emotionally draining (Hawker et al., 2008). As noted earlier, the experienced joint pain may not correspond to radiographic findings. Altered peripheral and central neurophysiological process, particularly higher pain sensitisation in people with lower limb OA in comparison to healthy individuals (Arendt-Nielsen, 2017; Fingleton et al., 2015; Kidd, 2012) are implicated in the pain

experience, along with psychological and cognitive processes (e.g., distress, pain catastrophising vs positive affect, self-efficacy, mindfulness) (Bartley et al., 2017).

Pain hurts, intervenes with daily life, can be overwhelming and being unable to relieve oneself from pain constitutes an extremely stressful experience (Taylor, 1995). Chronic pain is strongly associated with depression (Campbell et al., 2003; Fishbain et al., 1997) as well as fatigue (Fishbain et al., 2003). The pain- depression/anxiety association is evidenced in OA patients (Sharma et al., 2016). Higher proportions of people living with hip or knee OA report anxiety and depression (one in five) in comparison to general population as reported by a systematic review (Stubbs et al., 2016). Moreover, studies examining phenotypes in knee OA based on clinical outcomes (radiographic severity, muscle strength, BMI, comorbidities, depression), using data from a US osteoarthritis cohort study, identified a sub-group of patients predominantly characterised by high psychological distress, although they did not necessarily exhibit worse clinical outcomes on the other categories (Kittelson et al., 2016; Knoop et al., 2011). For example, other phenotypical categories were characterised by higher comorbidity rates, increased joint tenderness/ lower muscle strength, higher BMI/ lower muscle strength, no radiographic evidence/ average muscle strength (Kittelson et al., 2016; Knoop et al., 2011).

OA patients might get caught up in a downward spiral of interactions between physiological and psychological factors leading to disability and compromised quality of life (Moskowitz, 2009). Pain was found to predict future depressive symptoms via disability and fatigue in a path analysis model tested from a cohort lower limb OA sample (Hawker et al., 2011). Indeed, depressive symptoms (Possley et al., 2009; Riddle et al., 2011) and anxiety (Scopaz et al., 2009) have been independently linked to greater limitations in physical function. Furthermore, hip and knee OA patients often develop fear of movement and become

activity avoidant, which leads to further activity limitations (Gunn et al., 2017; Holla et al., 2014; Pisters et al., 2014).

With regard to general health indices, systematic review findings show that people living with OA are at higher risk of cardiovascular disease (Hall et al., 2016) and death due to cardiovascular disease (Veronese et al., 2016) than people without OA. Although the mechanisms underlying this association are not clear, there are potential implications for OA management, such as increased risk for complications in joint surgery and potential risk from the use of non-steroidal anti-inflammatory drugs (Hall et al., 2016). In addition, individuals with hip or knee OA are more likely to have insomnia and related sleep problems (Allen et al., 2008) and report compromised health-related quality of life overall (Salaffi et al., 2005) in comparison to asymptomatic controls. In summary, many aspects of physical health and well-being of people living with hip and knee OA are compromised. It is therefore important to take into account and enhance physical and mental health as part of OA treatment (ARUK, 2013).

Physical Activity as a Treatment Option for Hip and Knee OA

Hip and knee OA treatment typically refers to a variety of approaches ranging from conservative symptom management to operative procedures. OA is a chronic, progressive disease therefore treatment refers to long-term symptom management rather than cure/ full restoration of physical function and pain elimination. The core OA treatments include education, exercise and if overweight or obese, weight loss (NICE, 2014). Second line treatments include pharmacological treatments, local heat and cold, assistive devices, shock-absorbing footwear, manual therapy, braces and transcutaneous electrical nerve stimulation, intra-articular injections and joint surgery. Intrusive procedures depend on radiographic

findings with total joint replacement being the last resort in severely progressed OA (NICE, 2014).

Definitions of PA, exercise and sedentary behaviours

PA is defined by the World Health Organization as “any bodily movement produced by skeletal muscles that requires energy expenditure” (WHO, 2019). This is distinguished from exercise in that the latter is a subcategory of PA, namely a structured and purposeful form of PA. The above comprehensive definitions were introduced by Caspersen in 1985 and have been used extensively since (Caspersen et al., 1985). In addition, PA has been further classified with reference to various criteria such as purpose, type and metabolic equivalents (METs, which is the ratio of activity metabolic rate/ resting metabolic rate for a given individual) (Ainsworth et al., 1993). PA intensity, namely the amount of effort required by the individual in order to perform an activity, is of particular interest because time spent in certain intensity levels has been consistently associated with physical and mental health outcomes (WHO, 2019). More recently a conceptual framework of daily movement and non-movement behaviours was presented by the Sedentary Behaviour Research Network (Tremblay et al., 2017). The 24-hour daily period is divided into (a) sleep, (b) PA, classified as light, moderate and vigorous intensities, and (c) sedentary behaviour, including time spent in a sitting, reclining or lying position which requires minimal energy expenditure (≤ 1.5 METs) (Tremblay et al., 2017).

Following from the above, the terms light PA (LPA; 1.5-3 METs), moderate PA (MPA; 3-6 METs), vigorous PA (VPA; >6 METs) (WHO, 2019) and sedentary behaviours (SB)/ sedentary time (ST) (≤ 1.5 METs) are used throughout the thesis. PA is also referred to as “lifestyle” or “general” PA. Lastly, the terms “total” and “bouted” are also used to distinguish between ways of accumulation of a certain PA intensity/ ST measured by

accelerometers, i.e., total sum of every minute or sum of time spent in bouts of minimum 10-minute duration respectively.

PA in recommendations for the management of hip and knee OA

During the last couple of decades, effectiveness of exercise interventions on improving OA-related outcomes, mainly pain and physical function, has been extensively studied and subsequently informed recommendations for OA management: exercise, including muscle-strengthening, aerobic and neuromuscular, is recommended as a first-line non-pharmacological treatment worldwide: Ottawa panel (Brosseau et al., 2017a,b), European League Against Rheumatism (EULAR) (Fernandes et al., 2013), American College of Rheumatology (ACR) (Hochberg et al., 2012), OA Research Society International (OARSI) (McAlindon et al., 2014; Zhang et al., 2010). In these recommendations aerobic PA was discussed as a structure exercise regime rather than lifestyle PA.

More recently, objective PA measures have been incorporated in OA research and have enabled the study of overall PA, especially regarding the public health recommendations for moderate-vigorous PA (MVPA) (DHHS, 2008), and sedentary time in OA-outcomes. Existing evidence has showed that an active lifestyle (satisfactory amount of time spent in moderate-to-vigorous PA and less time spent sedentary or in prolonged sedentary bouts) is beneficial for physical function in lower limb OA (Dunlop et al., 2011; Lee et al., 2015; Pinto et al., 2017). Stemming from this body of research, the recent EULAR PA guidelines for OA and inflammatory arthritis emphasise the promotion of overall PA and reduction of sedentary time as part of OA health-care and place interventions promoting these behaviours in the research agenda (Rausch Osthoff et al., 2018).

Effectiveness of exercise interventions in hip and knee OA

Several systematic reviews of exercise interventions for people living with hip and knee OA have been conducted and conclude that exercise is effective for pain reduction and improvements in physical function, with medium/ medium to large effect sizes reported across meta-analytic reviews of overall moderate/ high quality studies with low risk of bias (Fransen et al., 2015; Fransen et al., 2014; Juhl et al., 2014; Uthman et al., 2013) and functional aerobic capacity with medium to large effect sizes (moderate or high quality evidence mostly) (Escalante et al., 2011) at the end of the programme. A meta-analysis of Cochrane systematic reviews comparing the effects of exercise and analgesics on pain revealed comparable effects between the two types of interventions (pharmacological interventions ES: 0.41, 95% CI= 0.23, 0.59); exercise interventions 0.46, 95% CI= 0.34- 0.59) (Henriksen et al., 2016).

Small to medium positive effects on walking ability (measured by timed walk tests) have also been found (Tanaka et al., 2015b), but are based on low quality evidence. Regarding quality of life, small beneficial effects have been reported for knee OA (Fransen et al., 2015), but not for hip (Fransen et al., 2014). Meta-analytic data showed better effects on pain for aerobic (ES: 0.52, 95% CI= 0.34, 0.70) than strengthening exercise (ES= 0.32, 95% CI= 0.23, 0.42) when hip and knee were examined (Zhang et al., 2010), although studies in knee OA only revealed similar effects for both types of exercise (SMD 0.67 and 0.62 for aerobic and strengthening respectively) (Juhl et al., 2014). Few existing, low quality studies that compared high and low intensity exercise programs revealed no clinically meaningful benefits for pain and physical function (Regnaud et al., 2015). It has also been noted that distinct benefits and risks are related to each type of exercise and an assessment of individual conditions to identify the most appropriate type or combination is recommended (McAlindon et al., 2014).

Lifestyle PA, sedentary behaviours and physical function in hip and knee OA

The adoption of a physically active lifestyle is a far more general concept than participating in structured exercise regimes. It involves all types of daily activities, e.g., leisure, transportation, work-related, activities of daily living. Besides the general benefits of PA on physical and mental health (Bouchard et al., 2012; Schmid et al., 2015), maintaining an active lifestyle has OA-specific benefits.

Two longitudinal, large scale, multicenter observational studies of people with or at risk of knee OA, namely, the Osteoarthritis Initiative (OAI, 2019) and the Multicenter Osteoarthritis Study (MOST) (Segal et al., 2013) have been a crucial source of evidence on the accrual of daily PA and sedentary time and its effects on lower limb OA. The OAI had 4,800 registered participants at the 48-month follow up (OAI, 2019) and the MOST study 2,638 participants at the 84-month follow up (MOST, 2019). Based on data from the OAI, higher levels of self-reported PA at baseline predicted better maintenance of physical function in six years' time (Batsis et al., 2016), whereas a graded increase in PA predicted improved physical function, measured by the performance at the 20-meter timed walk test, at two years' follow up (Dunlop et al., 2011).

In the MOST study, baseline step count had an inverse relationship with 2-year incidence of functional limitations, self-reported and objectively-assessed performance (White et al., 2013b). With regard to sedentary behaviour (SB), objectively measured ST at baseline predicted worse physical function in four years' time after controlling for MVPA (Semanik et al., 2015) and increased frailty incidence in two-years' time after controlling for moderate PA (Song et al., 2015). Using cross-sectional data from the OAI and after dividing the sample in sedentary time quartiles and controlling for MVPA, demographic and health-related factors, Lee and colleagues found the most sedentary group reported significantly worse physical functioning (Lee et al., 2015). It should be noted that a transition from lower

to higher PA levels can have positive effects. For example, in inactive OAI participants (i.e., who had zero bouts of objectively measured MVPA for a week), an increase in MVPA even to a level lower than the official recommendations (7.8 minutes per week on average), predicted less impaired physical function in a two year follow up (Song et al., 2017).

PA benefits might occur within certain boundaries of amount of PA. A minimum of 45 minutes per week of total, objective MVPA was identified as the threshold predicting improved or sustained physical function over a two-year period (Dunlop et al., 2017). Similarly, a cross-sectional study in Japanese sample with lower limb OA, engaging in less than 2,500 steps per day was an indicator of significantly impaired physical function (Iijima et al., 2017). Physical function was assessed by performance tests (timed walk and chair stand tests) and self-reported measures (Japanese Knee OA Measure-function). In contrast, data from an Australian older adult cohort study showed that doing $\geq 10,000$ steps per day at baseline was associated with higher risk for structural changes in the knee joint (e.g., RR: 1.52, 95% CI=1.05, 2.20 for meniscal pathology, 1.97, 95% CI=1.19, 3.27 for bone marrow lesions) in 2.7 years and the risk was more pronounced (e.g., RR :2.49, 95% CI=1.05, 3.93 for meniscal pathology) for those with baseline meniscal and cartilage pathology (Dore et al., 2013).

Accelerometer/ pedometer measured PA appears to be a valid measure of PA intensity in hip and knee OA: level-walking has been found to be the most common PA this population engages in, that is 92% of total PA time (Sliepen et al., 2018). One methodological limitation in the above studies is the classification of PA intensity and ST based on accelerometer data. In OAI, commonly applied cut points for counts per minute (Troiano et al., 2008) were based on validation studies with young, healthy adults. However, hip and knee OA onset is commonly in middle and older age and their prevalence increases with age. There might be

therefore limitations in the validity of the findings of studies regarding the association of PA intensities with examined health and well-being outcomes in OA populations.

Underlying biomechanical mechanisms of benefits of physical activity in osteoarthritis

The importance of a physically active lifestyle (without excessive joint loading) is supported by research on PA associations with the implicated biomechanical processes. With respect to articular cartilage, there are two facets to consider when examining its relationship to PA: high loads and absence of loads can be detrimental through damaging the collagen network and/ or leading to atrophy/ catabolic responses thus triggering or accelerating OA. Moderate mechanical loads on the other hand, stimulate the regulation of articular metabolic responses that lead to tissue preservation (Fox et al., 2009; Griffin and Guilak, 2005; Halilaj et al., 2018; Musumeci, 2016). In animal models, rats engaging in mild or moderate PA following induced joint injury had significantly less inflammatory markers and more chondroprotective biomarkers in the synovium than no-exercise control rats (Castrogiovanni et al., 2019; Musumeci et al., 2013). An illustration of the potential application of Castrogiovanni et al.'s (2019) model on human joints with OA is presented in Figure 1.3.

Analogous findings supporting a beneficial effect of moderate intensity PA on articular cartilage (in comparison to sedentariness or high PA levels comes from longitudinal studies using magnetic resonance imaging techniques on human participants at risk of OA (Hovis et al., 2011; Lin et al., 2013; Roos and Dahlberg, 2005) and with mild OA (Munukka et al., 2017). For example, Hovis et al. (2011) in a subsample from OAI compared sedentary, light (regularly engaging in walking or low-impact sports) and moderate-strenuous exercisers (regularly engaging in more strenuous sports) based on self-reported PA. They found that light exercisers presented better radiographic findings in comparison to those observed in the

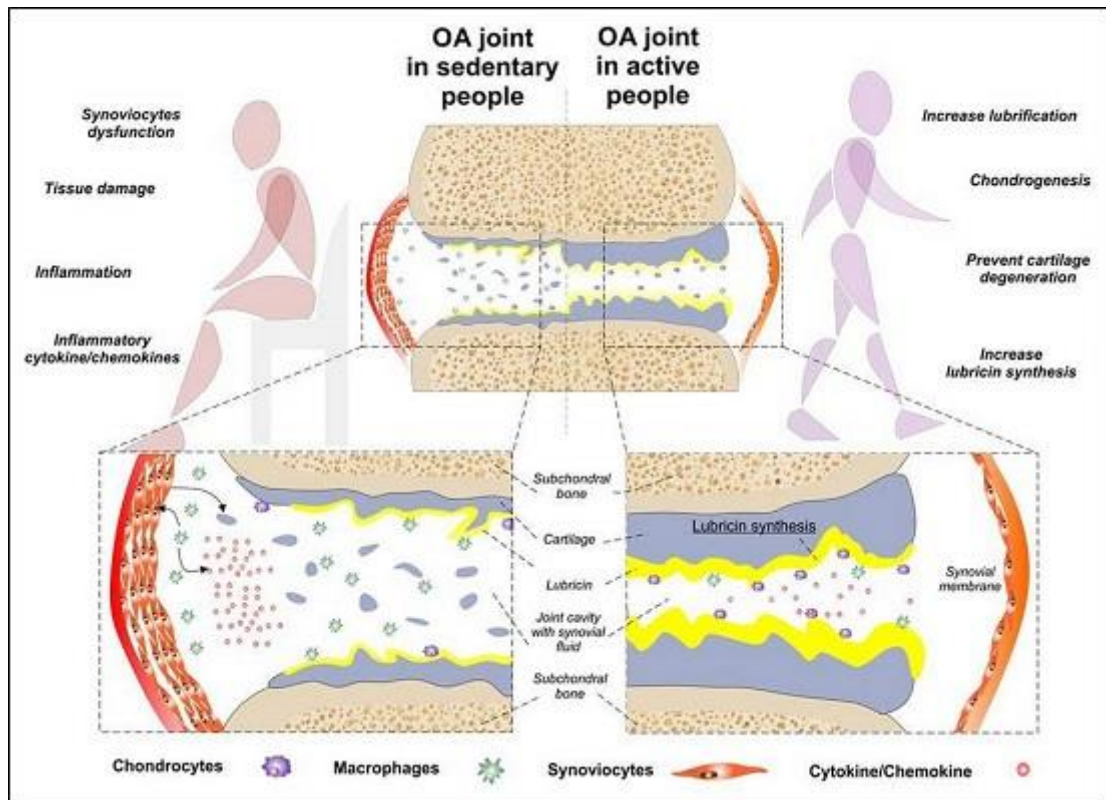


Figure 1.3 Moderate PA as a means of prevention of OA progression

Moderate PA as a means of prevention of OA progression in a joint with moderate OA in relation to physical activity, via its influence on the expression of synovial biomarkers: increase of anti-inflammatory and chondroprotective biomarkers (chondrocytes, synoviocytes) and decrease or no effect on OA-related cytokines. Reproduced with permission from Castrogiovanni et al. (2019).

sedentary (T2 values for lateral tibia, $p=0.04$) and moderate-strenuous groups (T2 values for lateral tibia, $p=.001$, and tibiofemoral joint, $p=.006$). No significant differences among PA-intensity groups were found in the healthy controls. In addition, radiographic findings were significantly worse in participants engaging in frequent knee bending PA both for the OA

cohort and controls (T2 values for tibiofemoral joint, medial femoral condyle, medial tibia, cartilage, $p \leq .011$) (Hovis et al., 2011).

Recently, Halilaj et al. (2018) highlighted that both PA and cartilage microstructure data are multidimensional entities and common statistical models cannot offer a sufficient understanding of their associations. They applied a more complex analysis (canonical correlation) to test associations between a Cartilage Microstructure Index (a multivariate index of changes in magnetic resonance imaging over four years at six femoral cartilage region) and a PA index (multivariate combination of objective ST, LPA, MPA and VPA at year four). They concluded that SB and vigorous PA may not be safe behavioural patterns for those at risk for knee OA (Halilaj et al., 2018). Poorer radiographic findings have also been reported for more progressed OA (Kumar et al., 2015), which calls for caution in identification of optimal PA prescriptions for different OA sub-groups. Other studies, based on self-reported PA, report null effects, and suggest that the examined PA modalities are unlikely to cause structural harm (Kwee et al., 2016; Van Ginckel et al., 2018). A systematic review and meta-analysis of effects of long term (12-18 months) exercise therapy on knee joint structure, revealed no significant effects on tibiofemoral disease severity (SMD: 0.06, 95% CI= -0.07, 0.20; moderate quality evidence), cartilage morphology (SMD: .06, 95% CI= -0.20, 0.36; low quality evidence) and synovitis (OR: 0.90. 95% CI= 0.51, 1.60; low quality evidence), although there was a negative effect on bone marrow lesions (OR: 1.90, 95% CI= 1.11, 3.26; low quality evidence, relevant to obese individuals with knee OA) (Van Ginckel et al., 2018). Similarly, no significant association was found between daily steps at a moderate to vigorous intensity and structural changes at two-year follow up in a subsample with/at risk for mild OA from the MOST study (Oiestad et al., 2015). It should be noted that PA levels were not high

in this population, i.e., PA inter-tertile ranges were <6078, 6078-7938 and >7938 steps (Oiestad et al., 2015).

How active are people living with hip and knee OA?

Given the existing evidence on the importance of a physically active lifestyle in people with hip and knee OA (NICE, 2014c; Rausch Osthoff et al., 2018), the next important question to examine is how active is this population. A systematic review by Wallis et al. (2013) aimed to answer the question of what proportion of people with hip or knee OA meet the official guidelines of 150 minutes of MVPA weekly, either in bouts (minimum duration 10 minutes) or total, based on studies using objective PA measures. Although there was great variability in the reported time among different studies, the authors concluded that only a small to medium proportion of the population met the guidelines (in particular, 13% for bouts MVPA in knee OA based on high quality evidence; 41/58% for total MVPA in knee/hip OA based on low quality evidence). Compared to aged matched controls in the included studies, individuals with OA were 25% less active (Wallis et al., 2013). Other studies have also reported low proportions of people with lower limb OA engaging in MVPA, e.g., less than 5.5% of the MOST sample, pedometer-based (White et al., 2013a) and less than 5% of an OAI subsample that had undergone or were about to undergo total knee arthroplasty, based on uniaxial-accelerometer data (Kahn and Schwarzkopf, 2015). With regard to SB, people with lower limb OA were spending two thirds of their waking hours being sedentary (Semanik et al., 2015). Notably, PA levels in individuals with OA tend not to change significantly, e.g., over a few years course of OA (Batsis et al., 2016) or from pre- to post-operative (Arnold et al., 2016).

It should be noted though, that translating literally the MVPA recommendations which were based on self-reported measures, when objective PA measures are employed might not reflect the MVPA level that corresponds to optimal health benefits for people living with OA (White et al., 2013a). In addition, although 10-minute bouts MVPA was included in the physical activity guidelines for Americans in 2008 (Department of Health and Human Services, 2008), this MVPA pattern was removed in the recent, second edition (DHHS, 2018). Whether bouts or total MVPA should be targeted in OA management as more beneficial, is still unclear. Nevertheless, only a small proportion of individuals with lower limb OA report engaging in PAs for managing OA (Hinman et al., 2015).

Promoting a physically active lifestyle in hip and knee OA: challenges and gaps

In light of the importance of PA for OA management and well-being and the low levels of PA engagement of individuals with hip and knee OA, the promotion of a physically active lifestyle is paramount. An active lifestyle has various components, the main ones being sufficient time spent in general daily PA, especially of moderate (or higher) intensity, muscle-strengthening exercises and sedentary time reduction (DHHS, 2018; Rausch Osthoff et al., 2018).

In lower limb OA, existing literature has predominantly focused on effectiveness and adherence (that is, correspondence of an individual's behaviour with health-care recommendations) related to interventions involving exercise for OA symptoms and physical function, rather than generic PA promotion. In this literature, post-intervention and long-term exercise adherence has received limited attention (Ezzat et al., 2015; Jordan et al., 2010), despite it being essential for gaining and sustaining intervention health benefits (Marks, 2012; Pisters et al., 2010a,b). A systematic review found that 6 to 15 months post intervention, the positive intervention effects on pain and physical function decrease and become non-

significant over time (low or moderate risk of bias) (Pisters et al., 2007). Although exercise is a distinct PA pattern, these findings suggest that mechanisms underlying PA behaviour, such as cognitive-motivational and social-environmental (Bandura, 1986; Ryan and Deci, 2000; Sallis and Owen, 2015), should be addressed in this population. Nicolson and colleagues (Nicolson et al., 2017) systematically reviewed and identified techniques related to such mechanisms in exercise interventions for hip/ knee OA and low back pain. Nine RCTs were included in their systematic review, six of which were on OA. Among the techniques used, booster sessions and behavioural graded exercise were identified as potential adherence facilitators in OA, whereas behavioural counselling, action coping plans and audio/visual exercises did not show significant effects (Nicolson et al., 2017).

With regard to general, lifestyle PA, a systematic review and meta-analysis of PA interventions in chronic musculoskeletal pain (four out of eight studies on OA, 634 participants) found no significant effects at short (<3 months), intermediate (3-12 months) and long-term (≥ 12 months) follow ups on objectively measured PA (Oliveira et al., 2016). Interventions included education and advice, goal-setting, text-message prompts, education targeting self-management, coping skills and self-efficacy, cognitive-behavioural PA, or PA programmes only including graded exercise. An earlier systematic review of pedometer-based interventions (predominantly walking programs) in musculoskeletal pain (4 out of 7 studies where on hip/ knee OA, 150 participants) reported an increase in step-count by 1950 steps on average across studies (Mansi et al., 2014). However, this finding does not represent pooled or long-term effect and in fact two out of the four studies on OA reported non-significant effects on PA post intervention (Mansi et al., 2014). In lower limb OA specifically, Williamson et al. (2015) systematically reviewed interventions utilising behavioural change techniques and reporting PA changes at least six months post intervention (11 studies, 2741

participants). The majority of interventions were self-management programs involving supervised exercise and targeting self-efficacy constructs and coping skills. Self-reported PA was the most common outcome measure with a non-significant pooled effect (SMD=0.22, 95% CI=-.11, .56). The authors underlined the need for methodological rigor, consensus with regard to outcomes, and optimal delivery of interventions (Williamson et al., 2015).

The above findings are not in line with findings from behavioural PA interventions on populations without chronic health conditions, specifically middle and older aged adults (Hobbs et al., 2013) and insufficiently active adults (Howlett et al., 2019). The latter systematic reviews reported positive intervention effects on PA engagement at 12 months (SMD: 1.08, 95% CI= 0.16 to 1.99; Hobbs et al. 2013) and at six months follow-up ($d = 0.21$, 95% CI = 0.12, 0.30; Howlett et al., 2019). One possible explanation of this discrepancy might be that there are certain PA-related issues specific to lower limb OA (Marks, 2012). With regard to SB reduction, existing work is limited. Howlett et al. (2019), who also examined effectiveness of interventions on ST reduction, found no significant effects.

PA promotion in people living with hip and knee might be more complicated than in the general population due to activity-related pain and difficulty with movement, mental distress, subsequent activity avoidance (Holla et al., 2014), as well as uncertainty about potential benefits and harm from PAs (Holden et al., 2012; Hurley et al., 2010).

Behavioural change theories: identifying physical activity determinants

The first step in effectively changing behaviour is understanding its determinants (namely factors that correspond to and are coupled with engagement in the behaviour) and the employment of theoretical frameworks of behaviour is essential in this process (Michie et al., 2008). Widely accepted types or levels of PA determinants are: individual (personal,

psychological/ cognitive), social and environmental (Biddle and Mutrie, 2008). Psychological/cognitive factors influencing PA behaviour have most extensively been studied and used in behaviour change interventions and public health (Biddle and Mutrie, 2008; Glanz and Bishop, 2010), as these have been considered key agents of PA behaviour (Bandura, 2004).

Social-Cognitive Theory (SCT) (Bandura, 1986; Bandura, 1997) and Self-Determination Theory (SDT) (Ryan and Deci, 2000) are two established theoretical frameworks that focus on psychological/ cognitive factors affecting behaviour, while acknowledging the influence of the social context. Importantly, these theories also specify pathways to (or the processes leading to) behaviour change, such as self-efficacy and autonomous motivation respectively. In brief, SCT posits that self-efficacy (a person's belief that he/ she can successfully perform a task/ has control over a behaviour), knowledge and expectations about benefits and risks related to the outcomes of the behaviour, personal goals and the social context (verbal persuasion and vicarious reinforcement) determine health behaviour (Bandura, 1986, 2004). Self-efficacy is a key determinant because of its direct and indirect (via other determinants) influence on behaviour (Bandura, 2004). Self-efficacy can be enhanced mainly through personal mastery experiences, but also through social factors, specifically vicarious experiences and verbal persuasion (Bandura, 2000b). It is the most commonly used construct in theory-driven interventions for PA promotion (Chase, 2015) and a common psychological outcome in exercise interventions for hip and knee OA (Hurley et al., 2018).

SDT focuses on the “why” of the behaviour and posits that a person is more likely to engage in a behaviour if their motivation is autonomous (self-determined), rather than externally regulated (Deci and Ryan, 2008; Teixeira et al., 2012). Autonomous motivation for

PA includes engaging in a behaviour because it is inherently pleasurable or as a means of achieving outcomes which are consonant with one's personal values and self-identity (Deci and Ryan, 2008). The social environmental influences on autonomous motivation are realised through supporting the individual's basic psychological needs (autonomy, competence and relatedness) and by adoption and internalisation of social values and practices by the individual (Ryan et al., 2009). The model has been tested and showed good fit in arthritis patients (Yu et al., 2015b).

Moving towards a broader-contextual understanding of behaviour, ecological models view behaviour as the outcome of multi-level determinants, including intrapersonal, interpersonal, wider socio-cultural context and physical environment (Sallis et al., 2006; Sallis and Owen, 2015). Individual-level changes will more likely be short-term if they do not take place under supportive policy contexts and physical environments and, vice versa, supportive environments cannot ensure the adoption of a health behaviour by the individual without affirmative personal agency- a combination is necessary. Ecological models do not identify behavioural determinants related to each level, but are integrative, in the sense that they can use multiple theories to specify such determinants (Sallis and Owen, 2015).

At the same time, OA is a health condition and its treatment inevitably is linked to health-care. As described earlier, PA is directly affected by OA, while being a treatment option for OA management. Understanding the personal meaning and manifestations of the illness and the patients' subjective experiences is essential for optimal health outcomes and human care. (Borrell-Carrio et al., 2004). The relevance of psychological and social processes to OA outcomes and the need for a holistic approach in OA treatment has repeatedly been emphasized (Bartley et al., 2017; Dziedzic et al., 2009; Hunt et al., 2008; NICE, 2014). This brings a model of healthcare in alignment with the models of behavioural change outlined

previously. Acknowledging the value of theoretical frameworks in understanding and changing behaviour, as well as the multidimensionality of factors influencing PA, health and well-being in OA, an integrated approach was adopted in this thesis for the examination of PA determinants. This allowed for more than one theories to be utilised in a complementary manner.

Overview of published systematic reviews on PA determinants in hip and knee OA

At the beginning of this thesis work (December 2014), a scoping search of the literature was conducted to map existing systematic reviews on PA determinants in hip and knee OA. The aim was to identify gaps in the existing literature, which would then inform the thesis objectives. Systematic reviews of primary research evidence are considered the “likely best” source of evidence to inform decision-making in health-care (Howick et al., 2009). Strengths of systematic reviews are that they (a) summarise potentially all available evidence through a systematic search and (b) appraise the quality of evidence from which conclusions are drawn.

Systematic reviews of studies on adults with hip or knee OA assessing any factors (disease-related, psychosocial, environmental) associated with or corresponding to PA engagement and written in English were identified through a search in databases Medline, Embase, PsychInfo, Cochrane Database of Systematic Reviews, CINAHL and DARE. Search terms comprised three themes, i.e., OA (including key words “arthritis”, “joint/ knee/ hip pain”), PA (including “exercise”) and review. Of the 607 unique search results screened, only two systematic reviews on factors associated with PA in hip or knee OA (Stubbs et al., 2015; Veenhof et al., 2012) were identified. The review of Stubbs and colleagues was an update of Veenhof et al. (2012) and was further assessed for its methodological and reporting quality using the AMSTAR tool (Shea et al., 2007). The score given by two independent reviewers

was 9/11, which shows good methodological and reporting quality overall. Detailed scores can be found in Appendix 1. The review included 29 quantitative studies on physical activity correlates and reported the findings under a Socio-Ecological framework, specifically distinguishing between demographic, physical, social, psychological and environmental PA correlates. Of the 170 identified PA correlates, only demographic and disease-related were consistently reported by at least four papers. PA associations with psychological, social and environmental factors were examined by one or rarely two papers, with the exception of depressive symptoms (five studies on “hip or knee” OA) and psychological QoL (three studies on hip OA).

Overall, this overview of systematic reviews revealed a striking paucity of quantitative data regarding psychological, social and environmental PA correlates in hip and knee OA. However, these types of modifiable factors are of interest when it comes to behaviour change and intervention planning. Existing qualitative literature had not yet been systematically reviewed. Qualitative research, which allows for in-depth exploration of phenomena under study, could hold promise in offering the insight that was missing from quantitative research. Therefore, a systematic review of qualitative evidence was undertaken as an important step in studying PA determinants in our population of interest.

Thesis aims

The aim of this thesis is to augment the current body of research with regard to the determinants of a physically active lifestyle in hip and knee OA through a range of methods. Drawing from a biopsychosocial approach to OA management and the Ecological, Social-Cognitive and Self-Determination frameworks of health behaviour, key physical, psychological and social-environmental factors linked to PA behaviours, especially MVPA,

and their complex associations are identified. Secondly, sedentary experiences in the context of OA and personal sense of well-being are explored.

Specific objectives were:

1. To gain a comprehensive picture of the existing literature on PA determinants, by systematically identifying, appraising and synthesising the existing qualitative literature on PA barriers and facilitators (Chapter 3).
2. Using objective PA measures, to address a potential methodological issue related to accelerometer-assessed PA behaviour in this population, that of PA intensity/ ST classification. Differences in (a) time spent in PA intensities/ ST, (b) proportion of people meeting MVPA guidelines and (c) MVPA associations with health and well-being indicators when using age-relevant vs common, non-age relevant cut points, are examined. Further, to examine the relevance of two different PA patterns, namely bouts or total daily MVPA, with health and well-being (Chapter 5).
3. Acknowledging the need to address physical health as well as psychological well-being in OA management and the role of a various levels/ types of PA predictors, to test an integrated model. Specifically, path analysis is employed to test the fit of the sequence of psychological (self-efficacy) and environmental (distance of facilities) predictors of accelerometer-assessed MVPA and in turn physical function and quality of life. Additionally, the implications of the two MVPA patterns, total and bouts, for the fit of the proposed model are examined (Chapter 6).
4. Since limited qualitative data exist on lifestyle PA and none on ST in hip and knee OA, to qualitatively explore PA and sedentary experiences in the context of OA and personal meanings of well-being (Chapter 7).

Thesis outline

Chapter 2 presents the protocol for a systematic review of qualitative evidence on PA barriers and facilitators in hip and knee OA. Chapter 3 is a systematic review of qualitative evidence on barriers and facilitators of PA in hip and knee OA. The findings, which mostly derived from exercise interventions, are presented under a biopsychosocial model of PA engagement in OA. Chapter 4 introduces in detail the quantitative methods relevant to the two subsequent chapters, in line with the systematic review findings. Specifically, a range of physical, psychological, social- and physical-environmental variables were assessed along with accelerometer-measured PA.

Chapter 5 employs objective PA measures and two variations of PA and ST classification, namely two sets of cut points for accelerometer data processing, one validated in a population of older adults and a commonly used one, validated in healthy, young adults. The Chapter then assess and compares time spent in various PA intensities/ ST, proportion of participants meeting MVPA guidelines and MVPA associations with health and well-being between the two sets of cut points. The relevance of two different patterns of MVPA accumulation (total, bouts) with health and well-being based on the latter comparisons, is also discussed.

Chapter 6 further looks into the complex associations of physical, psychological and environmental factors and PA in OA. Path analysis is employed to test a model of self-efficacy and proximity of neighbourhood facilities as predictors of MVPA (bouts and total) and in turn physical function and physical/ psychological quality of life.

Chapter 7 follows from the systematic review findings in Chapter 3, which indicated that limited qualitative work has examined lifestyle PA and ST in lower limb OA. The chapter

presents a qualitative exploration of how individuals with lower limb OA experience PA and sedentary time in their daily lives and in relation to their sense of well-being. Finally, chapter 8 provides an overview and discussion of the thesis findings, along with implications for future research and OA health-care.

CHAPTER 2

BARRIERS AND FACILITATORS TO PHYSICAL ACTIVITY IN PEOPLE WITH HIP OR KNEE OSTEOARTHRITIS: PROTOCOL FOR A SYSTEMATIC REVIEW OF QUALITATIVE EVIDENCE.

**Barriers and facilitators to physical activity in people with hip or knee osteoarthritis:
Protocol for a systematic review of qualitative evidence.**


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ABSTRACT

Introduction This protocol aims at describing the objective and methods to be followed in a systematic review of qualitative studies on barriers and facilitators to physical activity in people living with hip or knee osteoarthritis.

Methods and analysis The databases MEDLINE, EMBASE, PhychINFO, Web of Science, CINAHL, SPORTDiscus, Scopus and grey literature sources will be electronically searched. Hand search of qualitative-research-centred journals, reference screening of relevant reviews and inquiries to active researchers on the field will complement the search. Studies will be

selected if they apply qualitative or mixed-methods designs to directly explore factors that correspond to engagement in PA/ exercise or, the perceptions regarding PA/ exercise of people with hip or knee OA. The CASP Qualitative Checklist and the evaluative criteria of credibility, transferability, dependability and confirmability will be applied for the study appraisal. Two independent reviewers will perform the search, study selection and study appraisal. Thematic synthesis will be used for synthesising the findings of the primary studies and the process and product of the synthesis will be checked by a second researcher. ConQual approach will be used for assessing the confidence in the qualitative findings.

Ethics and dissemination This systematic review will inform our understanding of the physical activity determinants and how to optimise behaviour change in people living with hip or knee osteoarthritis. The review findings will be reported in the form of an article prepared for publication in a peer-reviewed journal and for presentation at a national or international conference. The study raises no ethical issues.

Registration number PROSPERO CRD42016030024

Keywords: hip/ knee osteoarthritis, physical activity, barriers, facilitators

Strengths and limitations:

- To the best of our knowledge this is the first systematic review of qualitative evidence on barriers and facilitators of physical activity in people with hip or knee OA. Further, differences in barriers and facilitators between (i) exercise and lifestyle PA and (ii) uptake and maintenance of PA will be explored. This will largely contribute to our

understanding of PA behaviours and provide information on how to optimise behaviour change in the population of interest.

- Rigorous methods will be applied informed by the Centre for Reviews and Dissemination and Cochrane Qualitative Research Methods Group guidelines and reported at all stages in line with the Enhancing Transparency in Reporting the Synthesis of Qualitative Research (ENTREQ) Statement.
- The level of confidence in each review finding will be reported.
- One limitation of this systematic review is that only papers written in English will be included.

Introduction

Osteoarthritis (OA) is a common joint disease and one of the main causes of disability in ageing populations (NICE, 2014). Physical activity (PA) has a key role in the management of OA. For instance, exercise, which is the structured and purposeful form of physical activity (Caspersen et al., 1985), is effective in reducing pain and improving physical function and health-related quality of life in knee and hip OA (Anwer et al., 2016; Fransen et al., 2015; Fransen et al., 2014; Juhl et al., 2014; Tanaka et al., 2015; Uthman et al., 2014). In addition, sedentary pursuits have been linked to a decline in physical function longitudinally irrespective of the time the patients spent in moderate-to-vigorous activities (Semanik et al., 2015). Maintaining a physically active lifestyle (namely time spent in leisure and non-leisure physical activities, not limited to engagement in exercise) is therefore important for people living with lower limb OA (NICE, 2014). Nonetheless the majority of people with knee or hip OA do not meet the guideline recommendations of at least 150 minutes of moderate-to-vigorous physical

activity (MVPA) per week and are reported to be less physically active than their counterparts without OA (Herbolsheimer et al., 2016; Wallis et al., 2013). Furthermore in the case of existing exercise interventions in this population, PA maintenance post-intervention is a major issue (Pisters et al., 2007; Williamson et al., 2015).

An emerging question is therefore what are the PA determinants in people with hip or knee OA, so that they can be optimally applied in healthcare practice and policymaking to improve health outcomes. Existing narrative (Marks, 2012; Marks and Allegrante, 2005) and systematic (Stubbs et al., 2015; Veenhof et al., 2012) reviews have addressed this question. In the most up-to-date quantitative systematic review of factors influencing PA in this population (Stubbs et al., 2015) demographic characteristics, physical function and symptom severity were the only PA correlates consistently reported by the studies. There was inconsistent association with psychological factors like mental health. The paucity of studies on social and environmental correlates of PA was highlighted in this review (Stubbs et al., 2015). When it comes to understanding behaviour and behaviour change though, personal (eg, cognitions, attitudes), as well as social and environmental factors are of major importance (Ajzen, 1991; Bandura, 2000a; Deci and Ryan, 2008; Sallis et al., 2008).

To date, no systematic work has captured these factors, with those identified which are modifiable potentially contributing to the development of interventions to promote the initiation and maintenance of PA in people with OA. Qualitative studies, which offer an in-depth exploration of the human experience, might prove more appropriate in illustrating the variety and interplay of psychosocial and environmental factors that facilitate or hinder PA specifically in people living with lower limb OA. A recent scoping review of quantitative and qualitative studies (Dobson et al., 2016) has mapped modifiable factors linked to exercise participation in patients with hip and knee OA using the Theoretical Domains Framework. This systematic

review of qualitative evidence will move one step further by applying rigorous methodology, such as quality appraisal of the included studies and confidence in the reported findings. Confidence in the reported findings is directly relevant to how informative and useful they can be in practice. In addition, two important distinctions of potential relevance to barriers and facilitators to PA will also be addressed in this systematic review. The first is a discrimination between barriers and facilitators to exercise and 'lifestyle' PA. The second is about the theoretical and empirical distinction between uptake and maintenance of PA, that is, whether PA is a newly introduced or reintroduced behaviour in a person's life or its regular engagement is part of one's lifestyle (Prochaska and di Clemente, 1982). Different factors can act as barriers and facilitators at different stages of behavioural change (in particular, when the focus is on adoption or maintenance), which holds practical implications when it comes to identifying key elements of behavioural interventions.

Objective

To identify, appraise and synthesise the existing qualitative evidence on barriers and facilitators to PA uptake and/or maintenance in people with hip or knee OA based on the patients' perceptions and experiences.

Secondary objectives are to explore differences in barriers and facilitators between (1) exercise and lifestyle PA and (2) uptake and maintenance of PA.

Methods

This systematic review protocol follows the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols (PRISMA-P) 2015 statement (Moher et al., 2015; Shamseer et al., 2015). The systematic review was registered with the International Prospective Register of Systematic Reviews (PROSPERO), registration number CRD42016030024. It will

be informed by the Centre for Reviews and Dissemination (CRD, 2009) and Cochrane Qualitative Research Methods Group (Noyes et al., 2008; Noyes et al., 2011) guidelines and will follow the Enhancing Transparency in Reporting the Synthesis of Qualitative Research (ENTREQ) (Tong et al., 2012) and the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA; Moher et al., 2009; Appendix 2.1) statements for reporting systematic reviews. In the case of sections applicable to qualitative systematic reviews that are included in PRISMA, but are not covered by ENTREQ, these will also be reported.

Eligibility criteria

The criteria outlined below will be used for study selection. PICOS (Population- Intervention- Comparison- Outcomes- Study design) was adapted for use in this study. In particular, interventions and comparators were not applicable and the phenomenon of interest will be identified instead.

Population. Study participants will be adults who have physician-diagnosed hip or knee OA; or radiographic OA using Kellgren and Lawrence grade ≥ 2 at hip or knee; or meet internationally accepted classification criteria for OA (eg, American College of Rheumatology classification criteria). If the study population involves groups of patients with other types of arthritis, for example, rheumatoid arthritis, they will be included in this study provided that patients with knee and hip OA combined are the highest proportion of participants. Studies will be excluded if the study participants are people about to undergo or have undergone total hip or knee arthroplasty.

Outcomes will be barriers and facilitators that influence uptake and/or maintenance of PA in people with OA as perceived and reported by the patients. Studies will be included if (1) they directly explore the factors/barriers/facilitators/motivation that correspond to engagement in

PA/exercise (ie, this is stated in the study objectives or relevant interview questions are included); or (2) they directly address or focus on any aspect of the experience or perceptions of people living with hip or knee OA regarding PA and/or exercise.

Study designs (1) Qualitative studies using appropriate methods of data collection and data analysis. (2) Mixed methods studies that report qualitative findings.

Language studies will be excluded if written in a language other than English.

Publication year. From database inception to 31 December 2015.

Information sources

The databases MEDLINE (Ovid MEDLINE(R) In-Process and Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present, OVID interface), EMBASE (1974 onwards, OVID interface), PsycINFO (1967 onwards, OVID interface), Web of Science, CINAHL, SPORTDiscus and Scopus will be searched from inception to 31 December 2015. Also, grey literature sources will be considered, that is, OpenGrey, National Health Service (NHS) evidence. Hand search of qualitative research-centred journals, for example, Qualitative Health Research, Sociology of Health and Illness, will complement the search strategy. Screening of the references of included articles and relevant existing reviews will take place. Finally, active researchers in the field who have contributed to this literature will be contacted.

Search

The search strategy will comprise comprehensive keyword combinations for each of the four concepts of interest (see Appendix 2.2 for MEDLINE), that is, (1) knee and hip OA (1–9 in the appendix), (2) PA/exercise (10–16), (3) barriers, facilitators, motivation, uptake, maintenance (17–24), (4) qualitative study design (25–30). Free-text search (.mp) will be applied for the basic search terms for each concept (eg, ‘osteoarthritis’ for population; ‘physical

activity', 'exercise' for phenomenon of interest; 'barrier*', 'facilitator*', 'motivation' for outcomes; 'qualitative' for study design), supplemented by a wide array of alternative terms searched for in the title/abstract section or free-text search. Within each group of concepts, the keyword combinations will be mutually inclusive ('OR' operator). The combination of the four groups was applied in the latter stage using the AND operator.

Study records

The study selection process will be according to the PRISMA flow diagram (Moher et al., 2009). Two independent reviewers will run the search and study selection. Endnote X7 software will be used for data management. Citations including abstracts will be imported and duplicates will be removed. Selected articles will be juxtaposed for multiple reports of a single study, so that double counting of studies is avoided.

The predetermined eligibility criteria will be used in the form of a list (Appendix 2.3), which will be checked and fine-tuned if necessary by the two reviewers. The reviewers will independently apply the criteria at all stages of the selection process. After title/abstract screening, full-text copies of potentially relevant studies will be obtained. Additional information will be sought from authors if necessary at the stage of full-text assessment. Where the information provided is insufficient for study selection, assessment and synthesis, the respective studies will not be included in the synthesis but will be referenced in the discussion section. Consensus will be reached through discussion and where agreement is not reached, a third reviewer will be consulted. At the end of the selection process, the κ statistic (McHugh, 2012) will be used to assess the chance-corrected agreement between the reviewers in assessing the full-text articles as included, excluded or unclear. A supplementary table with information about the selected studies will be provided including study characteristics (first author's name, publication year, method of data collection and data analysis), participant characteristics (age,

gender, locus and severity of OA, duration of diagnosis, physical activity profile) and contextual information (country, geographic area, setting if applicable). Data will be entered in and managed with NVivo V.11 qualitative data analysis software (QSR International).

Data items

All text under the sections of ‘results’ and ‘findings’ will be considered as data and will be analysed. If findings and discussion are presented together, then discussion will also be considered as a data item.

Outcomes and prioritisation

Phenomenon of interest. The description and interpretation of patients with OA experiences and perceptions regarding what hinders and what facilitates and motivates them to engage in PA behaviours constitute the phenomenon of interest. All types of factors reported by the participants will be included, for example, health-related, psychological, social, cultural, environmental. Subgroups of the phenomenon of interest will also be explored, provided that there is sufficient evidence. These are: barriers and facilitators to PA uptake and PA maintenance; engagement in exercise and engagement in lifestyle PA.

Appraisal of study quality

Since there is no consensus on how to assess qualitative evidence and a single set of criteria might not be applicable to all kinds of qualitative research (Creswell, 2007; Sparkes, 2014), two different approaches to appraisal will be applied.

First the Critical Appraisal Skills Programme (CASP) Qualitative Checklist, a structured tool commonly employed in systematic reviews (SRs) of qualitative evidence, will be used. CASP Qualitative Checklist is broadly suitable for various qualitative study designs, is available online and free of charge. The tool, including introduction, 10 questions and

prompts, will be used as provided by the CASP-uk.net. Studies will be rated as ‘high quality’ if they meet at least 8 of the 10 criteria, ‘medium quality’ if they meet 5–7 of the criteria and ‘low quality’ if they meet 4 or less.

Although the CASP tool appraises reporting and methodological quality, it does not address aspects of the research validity (Hannes, 2011) and can favour papers that are less insightful as long as they comply with ‘expectations of research practice’ (Dixon-Woods et al., 2007). To address this gap, the evaluative criteria of credibility, transferability, dependability and confirmability (Lincoln and Guba, 1985) will be applied (Appendix 2.4). These criteria widely acknowledge the philosophical stance of qualitative research, focus on the trustworthiness of the study (Lincoln and Guba, 1985; Munn et al., 2014) and their development was not aimed in particular at the evaluation of interpretive qualitative approaches as other theoretically informed tools, for example, Popay et al. (1998). Included studies will be assessed as to whether they apply the techniques suggested for ensuring study quality according to Lincoln and Guba's criteria (Cohen and Crabtree, 2006; Creswell, 2007): prolonged engagement, persistent observation, peer review, triangulation, negative case analysis, referential adequacy and member checking to ensure credibility; thick description for transferability; inquiry audit for dependability; confirmability audit, audit trail, triangulation and reflexivity to ensure confirmability. A more detailed description of the context of the above procedures can be found in Appendix 2.4. Studies will be rated as ‘high quality’ if they meet at least three of the four criteria, ‘medium quality’ if they meet two of the criteria and ‘low quality’ if they meet one or none.

Two reviewers, both with qualitative research training and experience (AMK/NE) and one with additional experience in qualitative systematic reviews (NE), will independently appraise the selected studies. First, the appraisal process will be piloted, that is, the reviewers

will independently apply the two sets of criteria on two studies and criteria and then compare the outcome and discuss the process they followed, so that potential discrepancies in applying the criteria are resolved. The final assessment for each study will be reached through discussion and in case a consensus is not reached, a third researcher will be consulted. A detailed justification of the assessment outcome for the second set of criteria will be available on publication of the SR.

Data synthesis

Thematic synthesis as described by Thomas and Harden (2008) will be applied for data synthesis. Thematic synthesis is a transparent and suitable method for integrating qualitative evidence in a SR and has been used for SRs of barriers and facilitators to various behaviours (Anderson et al., 2014; Ferrer et al., 2014; Mazarello et al., 2015). The synthesis involves three stages: (1) free line-by-line coding; (2) grouping of the codes into ‘descriptive themes’, which also includes the translation of conceptions from one study to the other (i.e., the codes from all included studies will be compared with each other in an iterative process, the codes/quotes describing the same concept will be merged under one code and those expressing a similar concept will be grouped together); and (3) the formation of analytical themes. At the latter stage, barriers and facilitators to PA in people with hip and knee OA will be inferred from the descriptive themes; that is, the research questions, which are put aside during the data-driven first two stages, will be introduced at this point to inform the formation of analytical themes. Therefore, the synthesis will combine both an inductive (at first stages) and a deductive (latter stage) approach. The analytical themes and their relation with descriptive themes will be presented in tables. The synthesis will be conducted by one researcher (AMK) and checked by a second independent reviewer with experience in thematic analysis (NE), to enhance credibility.

Confidence in the synthesised qualitative findings

Assessing the quality of the studies in a SR does not answer the question of how much certainty or trust we can place on each individual review finding. To ensure the potential value of the review in informing its users, the assessment of the trust that can be placed on each individual finding is advised (Lewin et al., 2012). In qualitative evidence syntheses, approaches to confidence in the findings have only recently been developed (Munn et al., 2014; Lewin et al., 2015). The ConQual approach (Munn et al., 2014), which was developed by qualitative research experts from the Joanna Briggs Institute in Adelaide, will be adopted for assessing the confidence in the findings. ConQual assesses the confidence in findings, that is, truth value, based on two elements: dependability and credibility. ConQual is the approach of choice as it offers a clear operationalisation of each element and description of the appraisal process. A Confidence in the Findings Table will be formulated which will include the review finding, the assessments for dependability, credibility and the overall confidence score (high, moderate, low, very low).

Discussion

This systematic review will be the first to synthesise and report barriers and facilitators of PA in people with hip or knee OA based on qualitative evidence. Following the emerging evidence on the independent role of sedentary pursuits on health and mortality (de Rezende et al., 2014; Loprinzi et al., 2016) and the shifting of health guidelines and policies from exercise promotion to physical activity promotion, we will further explore differences between determinants of lifestyle PA and exercise, as there is a pronounced gap in the literature regarding the former (Koenen et al., 2011). Additionally, we will explore differences reported in the literature between uptake and maintenance of PA. The review findings will

inform our understanding of factors facilitating or inhibiting participation in physical activity and provide information on how to optimise behaviour change at different stages (ie, uptake or maintenance) in the targeted population.

This protocol serves to provide a detailed account of the rationale and methods to be used in the proposed systematic review to ensure the transparency of the process (Moher et al., 2014). In case any deviation from the protocol takes place, it will be justified and discussed in the systematic review on publication.

Acknowledgments

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Footnotes

Collaborators Dr Nikolaos Efstathiou.

Contributors JLD, AMK, AR, RK and AA contributed to the development of the study design and search strategy. RK and AA provided expertise on the selection criteria. AR provided expertise on the methodological issues related to systematic reviews. AMK developed the SR protocol and all authors provided feedback and approved the final protocol.

Funding This review will comprise part of the research requirements of a PhD to be completed by AMK, which has received funding by the MRC-Arthritis Research UK Centre for Musculoskeletal Ageing Research.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

CHAPTER 3

BARRIERS AND FACILITATORS OF PHYSICAL ACTIVITY IN KNEE AND HIP OSTEOARTHRITIS. A SYSTEMATIC REVIEW OF QUALITATIVE EVIDENCE

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Abstract

Background. Physical activity (PA), including engagement in structured exercise, has a key role in the management of hip and knee osteoarthritis (OA). However, maintaining a physically active lifestyle is a challenge for people with OA. PA determinants in this population need to be understood better so that they can be optimised by public health or healthcare interventions and social policy changes.

Objectives. The primary aim of this study is to conduct a systematic review of the existing qualitative evidence on barriers and facilitators of PA for patients with hip or knee OA. Secondary objective is to explore differences in barriers and facilitators between (1) lifestyle PA and exercise and (2) PA uptake and maintenance.

Methods. Medline, Embase, Web of Science, Cumulative Index to Nursing and Allied Health Literature, SPORTDiscus, Scopus, Grey literature and qualitative journals were searched. Critical Appraisal Skills Programme-Qualitative checklist and Lincoln and Guba's criteria were used for quality appraisal. Thematic synthesis was applied.

Findings. Ten studies were included, seven focusing on exercise regimes, three on overall PA. The findings showed a good fit with the biopsychosocial model of health. Aiming at symptom relief and mobility, positive exercise experiences and beliefs, knowledge, a 'keep going' attitude, adjusting and prioritising PA, having healthcare professionals' and social support emerged as PA facilitators. Pain and physical limitations; non-positive PA experiences, beliefs and information; OA-related distress; a resigned attitude; lack of motivation, behavioural regulation, professional support and negative social comparison with coexercisers were PA barriers. All themes were supported by high and medium quality studies. Paucity of data did not allow for the secondary objectives to be explored.

Conclusion. Our findings reveal a complex interplay among physical, personal including psychological and social-environmental factors corresponding to the facilitation and hindrance of PA, particularly exercise, engagement. Further research on the efficacy of individualised patient education, psychological interventions or social policy change to promote exercise engagement and lifestyle PA in individuals with lower limb OA is required.

Trial registration number: CRD42016030024

Keywords: barriers; facilitators; osteoarthritis; physical activity; systematic review

Strengths and limitations of this study

- This systematic review is the first to identify, appraise and synthesise the existing qualitative research on barriers and facilitators to physical activity (PA) in knee and hip osteoarthritis.
- Rigorous methods have been applied, informed by the Centre for Reviews and Dissemination and Cochrane Qualitative Research Methods Group guidelines and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses and Enhancing Transparency in Reporting the Synthesis of Qualitative Research statements.
- The majority of the included studies (7/10) focused on exercise barriers and facilitators; therefore, barriers and facilitators of more general lifestyle PA might not be fully captured.
- Papers written in English-language only were included.

Introduction

Osteoarthritis (OA) is the most common joint disease and main cause of disability in older adults (NICE, 2014a). OA management focuses on analgesia and non-pharmacological modalities such as exercise and weight loss (McAlindon et al., 2014). Exercise, i.e. structured and purposeful physical activity (PA) (Caspersen et al., 1985), reduces pain and improves function in people with knee or hip OA (Anwer et al., 2016; Boesen et al. 2006; Fransen et al., 2015; Fransen et al., 2014; Juhl et al., 2014; O. Uthman et al., 2013). However, despite the positive effects on symptoms, exercise interventions do not promote sustained behaviour change (Pisters et al., 2010a; Pisters et al., 2007). Just like exercise, PA associates with better physical function (Batsis et al., 2016; Chmelo et al., 2013; Lin et al., 2013), and even modest increase in PA (from sedentary to light intensity PA) improves arthritis pain (Loprinzi et al., 2014). At the population level, it is simpler to promote PA in people with painful OA e.g. via radio and television, than promoting exercise as that will require a greater behaviour change and may need continued support of trained physiotherapists. However, existing evidence suggests that people with lower limb OA have such low PA levels that they gain no health benefits from it (Austin et al., 2012; Austin et al., 2009; Herbolzheimer et al., 2016). Thus, there is need to understand the determinants of reduced PA in people with symptomatic OA so that these can be optimised to promote PA.

The disease specific determinants of PA in those with lower limb OA e.g. symptom severity, physical function (Dobson et al., 2016; Marks, 2012; Marks and Allegrante, 2005; Stubbs et al., 2015; Veenhof et al., 2012) are relatively well understood, but the psychological, social and environmental determinants of PA in OA have not been adequately examined (Stubbs et al., 2015; Veenhof et al., 2012). Understanding these factors is of great importance as pain makes PA an aversive experience leading to activity avoidance (Hawker et al., 2008;

Holla et al., 2014; Holla et al., 2015; Sanchez-Heran et al., 2016) and pain is influenced by psychological and environmental factors (Somers et al., 2009; Wideman et al., 2014; Herbolsheimer et al., 2016). A recent scoping review identified several psychological and environmental barriers and facilitators of exercise in people with hip or knee OA (Dobson et al., 2016). However, scoping reviews lack the methodological rigor of SRs (Arksey, 2005). A SR of qualitative data holds promise for a thorough and in-depth understanding of the modifiable psychosocial factors predicting PA behaviour.

The objectives of this study were to identify, appraise and synthesise the existing qualitative evidence on barriers and facilitators to PA in hip or knee OA, and explore differences in barriers and facilitators between lifestyle PA accrued in daily activities, and those reported in regard to structured exercise programs specifically; and between PA uptake and maintenance.

Methods

This SR was registered with the International Prospective Register of SRs (CRD42016030024) and its protocol reported previously (Kanavaki et al., 2016). The reporting follows the Preferred Reporting Items for SRs and Meta-Analyses (PRISMA) and the Enhancing Transparency in Reporting the Synthesis of Qualitative Research (ENTREQ) statements. Population, Intervention, Comparators, Outcomes were adapted to inform eligibility.

Eligibility criteria

Population. Study participants were adults with physician diagnosed or radiographic (Kellgren and Lawrence grade ≥ 2) hip or knee OA, or met classification criteria for OA at these joints (Altman, 1991). If a study included people with other arthritis, e.g. rheumatoid arthritis,

they were included if people with knee or hip OA were the largest proportion. Studies with participants awaiting total joint replacement were excluded.

Outcomes. The perceptions of barriers and facilitators that influence uptake or maintenance of PA were the study outcomes. Studies were included if they explored the factors/barriers/facilitators/motivation to engagement in PA or addressed the experience of people with hip or knee OA regarding PA or exercise.

Study designs. Qualitative or mixed methods studies.

Language. Published in English.

Information sources

MEDLINE (Ovid MEDLINE(R) In-Process and Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present, OVID), EMBASE (1974 onwards, OVID interface), PsycINFO (1967 onwards, OVID), Web of Science, CINAHL, SPORTDiscus and Scopus were searched up to 31 of December 2015. Grey literature sources were explored, i.e. OpenGrey, NHS evidence. The search strategy was complemented by hand search of qualitative-research-centred journals screening of references of included articles and contacting researchers active in the field.

Search

The search strategy contained exhaustive keyword combinations for each of the four concepts of interest, i.e. knee or hip OA; PA/exercise; facilitators, barriers, motivation, uptake, maintenance; qualitative studies (Appendix 2.2).

Study selection

The search and study selection was conducted by two researchers independently (AMK and AsA). Endnote X7 was used for data management. Citations and abstracts were imported and duplicates removed. After title/abstract screening, full text of potentially relevant studies were assessed and additional information was sought from authors where necessary. If consensus was not reached between the two researchers, a third reviewer was consulted (AR).

Data collection and appraisal

All text under the sections of “results” and “findings” of the selected studies was considered as data items. Where findings and discussion were presented together, the whole section was considered for analysis. Data items were entered into and managed with NVivo 11 qualitative data analysis software (QSR International).

Quality appraisal aimed to assess the reporting, methodological rigor and conceptual consistency of the included studies (Noyes et al., 2011) and to identify and discard low quality studies. Two approaches were used, which complement each other (Kanavaki et al., 2016): (a) the Critical Appraisal Skills Programme (CASP) Qualitative Checklist (Munn et al., 2014). Studies were rated as high, medium and low quality if they met ≥ 8 , 5-7, and 4 or fewer criteria respectively; (b) the evaluative criteria of credibility, transferability, dependability and confirmability that assess the trustworthiness of the study. Studies were rated high, medium, and low quality if they met ≥ 3 , 2, or 1 and less criteria (Creswell, 2007). Two reviewers independently appraised the selected studies (AK, NE).

The phenomenon of interest was the description and interpretation of OA patients' perceptions and experiences regarding what facilitates, motivates or hinders them from

engaging in PA. In addition, observed differences in facilitators and barriers to uptake and maintenance of PA (exercise and lifestyle PA) were also included.

Synthesis of results

Data were analysed by thematic synthesis (Barnett-Page and Thomas, 2009). First, authors' interpretations and informants' quotes were coded separately, line by line. Codes of original themes, subthemes and codes clearly referring to other types of arthritis were excluded from the synthesis. Next, descriptive themes were formed through code merging and grouping in a highly iterative process, creating a hierarchical tree. To form the analytical themes, a data driven analysis was initially conducted to allow an inductive interpretation. A group (AMK, NE, AR, JLD) review meeting was held and the fit of this synthesis within theoretical models of behaviour change, motivation, human development and health was examined. The findings showed good fit with the biopsychosocial model of health (Engel, 1980) which was chosen to facilitate a more comprehensive and meaningful interpretation of the data and reporting of the findings. The descriptive themes were then re-examined and refined. At this point the research question was introduced to help infer the barriers and facilitators under the three domains of the biopsychosocial model. To enhance the credibility of the findings the synthesis was conducted by AMK and checked independently by NE.

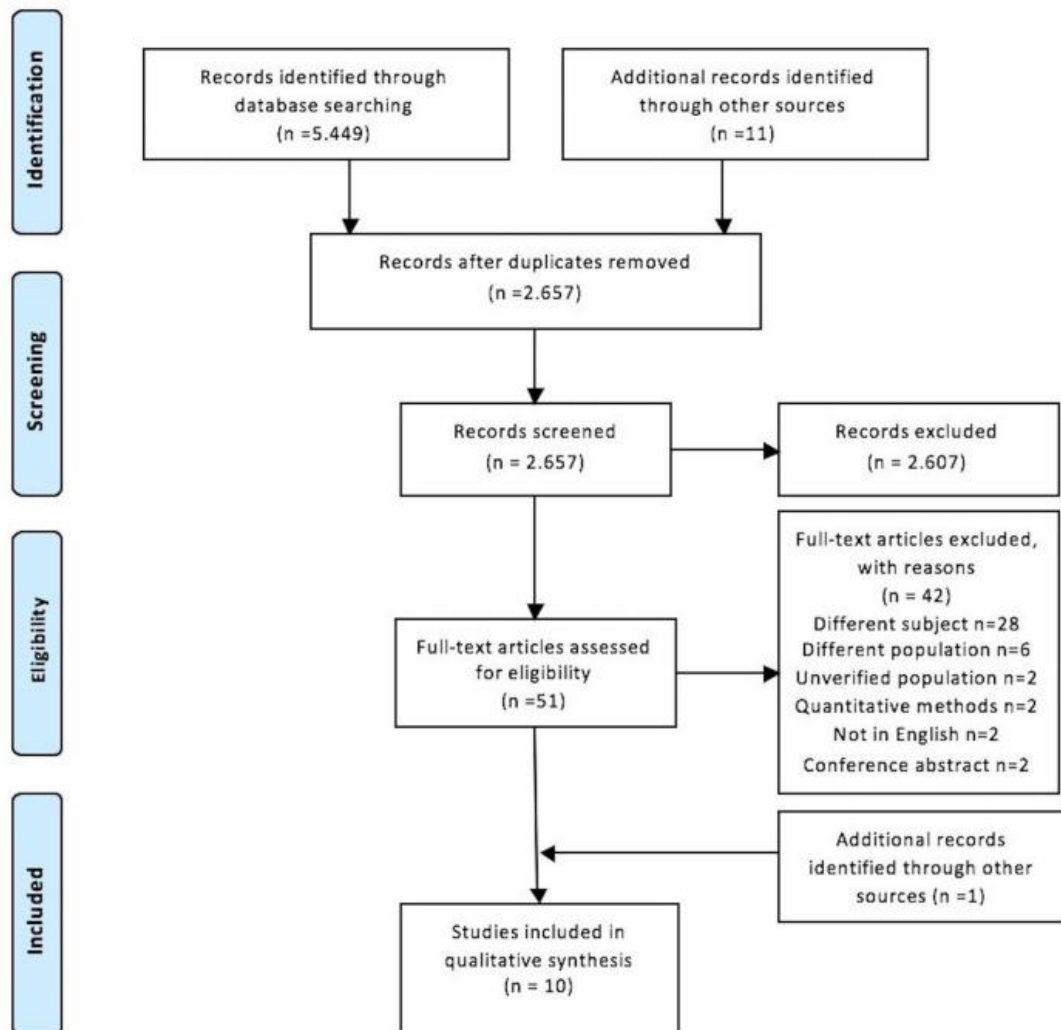
Additional analysis

The descriptive study characteristics were examined in relation to the secondary research objectives. Due to insufficient evidence no further analysis was conducted.

Results

Study selection

5,449 studies were identified, and after removing duplicates, 2,657 titles or/and abstracts were screened and 51 full-text papers were assessed. Seven authors were contacted for further information. Information was not provided for two studies, which were excluded.



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed.1000097

For more information, visit www.prisma-statement.org.

Figure 3.1 Study selection PRISMA flow diagram

Ten studies were included (Campbell et al., 2001; Fiskén et al., 2015; Hammer et al., 2015; Hendry et al., 2006; Kabel et al., 2014; Kaptein et al., 2013; Petursdóttir et al., 2010; Stone and Baker, 2015; Thorstensson et al., 2006; Veenhof et al., 2006) (Figure 3.1 for the PRISMA flow diagram).

Study characteristics

There were 173 participants, mainly middle aged to older, and female. Nine of ten studies reported qualitative methodologies (Table 3.1).

Appraisal of studies

All selected studies were of medium or high quality (Table 3.2). The research design and data analysis were not clear or well described in half of the studies and very few studies had clearly identified the relationship between the researcher and participants. Credibility, transferability and confirmability were met by almost all studies, although dependability only by two.

Synthesis of results

Barriers and facilitators are presented under the three conceptual domains, i.e. physical health, intrapersonal factors and social-environmental factors. Barriers and facilitators that appeared in at least three studies are reported, to keep a balance between richness and applicability of the findings (Table 3.3; Appendix 3.1 for supporting references). When comparing exercise and PA focused studies, the themes were similar in context and equally represented in most cases. Where there are differences, these are reported.

Study	Objectives	Country	Participants (number; diagnosis/ OA site; characteristics; sampling)	Methods (Data collection and analysis)	Findings	Relevance to Secondary Objectives (Exercise vs lifestyle PA; uptake vs maintenance)
Campbell et al. (2001)[39]	Compliance with a physiotherapy intervention.	UK	20 participants; Knee OA 14 female, age >45; Maximum variation sampling.	Interviews; constant comparative method	Factors related to compliance: moral obligation towards the physiotherapist (initial compliance); viewing exercise as beneficial, fitting exercises in daily life, perceived symptom severity, arthritis and comorbidity attitudes, exercise and OA experiences (continued compliance).	Exercise regime. Both initial and continued compliance explored.
Fisken et al. (2015)[40]	Reasons for ceasing participation in aqua based exercise.	New Zealand	11 participants; various OA sites, 10 hip or knee; female; age >60; purposeful sampling	Focus groups; general inductive thematic approach.	Main barriers: lack of appropriate classes and knowledgeable instructors, increase in pain, cold water and facilities.	Exercise regime. No uptake-maintenance distinction.
Hammer et al. (2015)[41]	Self-efficacy in relation to PA maintenance among maintainers and non-maintainers post-intervention	Denmark	15 participants; Hip OA; 8 female, age 65-74; Criterion based purposeful sampling.	Semi-structured interviews; directed content analysis.	Themes: mastery experiences, vicarious experiences, verbal persuasion, physiological and emotional states, altruism.	Exercise regimes. No uptake-maintenance distinction.

Hendry et al. (2006)[42]	Views towards exercise, determinants of acceptability and motivation, barriers.	UK	22 participants; Knee OA; 16 female, age 52-86; Purposeful sampling (inclusion/ exclusion criteria).	Interviews and focus group; Principles of Framework method of qualitative analysis.	Exercise participation determinants: perception of physical capacity, beliefs about exercise, motivational factors.	Exercise (broad definition). No uptake-maintenance distinction.
Kabel et al. (2014)[43]	Pain, social pressure and embarrassment in activity related decision making.	USA	10 participants; knee OA; 7 female, mean age 60; sampling method not clearly reported.	Interviews; Grounded theory or constant comparative method	Four PA-related patterns: Risk pain and embarrassment; risk pain, avoid embarrassment; avoid pain, risk embarrassment; avoid pain and embarrassment.	PA (living with OA).No uptake-maintenance distinction.
Kaptein et al. (2014)[44]	PA perception in the context of managing arthritis and multiple roles.	Canada	40 participants; 17 hip/knee OA, 16 RA, 4 both OA and RA, 3 other OA sites; 24 female, ages 29-72; purposeful sampling.	Focus groups; Qualitative content analysis	Positive PA perceptions, complex relationship between PA, arthritis and life roles (PA as potential cause of arthritis, reciprocal relationship, harms and benefits, perceived choices).	PA No uptake-maintenance distinction.
Petursdottir et al. (2010)[45]	Exercise experience. What determines	Iceland	12 participants; various OA sites, 10 hip or knee;	Interviews; Phenomenology (Vancouver School)	Barriers/ facilitators: internal (individual attributes and exercise experiences) and external (social and physical environment).	Exercise No uptake-maintenance distinction.

	whether people exercise		9 female, mean age 67 (50-81); Purposeful sampling			
Stone and Baker (2015)[46]	Facilitators and barriers to regular PA	Canada	15 participants, Hip or/and knee OA; 9 female, age 30-85; Snowball sampling.	Semi-structured interview; Interpretational analysis	Facilitators: pain relief, clear communication from health-care professionals, social support. Barriers: pain, psychological distress, lack of support from health care professionals	PA No uptake-maintenance distinction.
Thorstensson et al. (2006)[47]	Underlying processes leading to response or non-response to exercise as treatment	Sweden	16 participants, knee OA; 6 female, age 39-64; purposeful sampling	Interviews; Phenomenography	Themes: to gain health, to become motivated, to experience the need for support, to experience resistance.	Exercise No uptake-maintenance distinction.
Veenhof et al. (2006)[48]	Factors that explain differences between patients who integrated activities in their daily lives or not.	Netherlands	12 participants; hip or knee OA; 8 female, ages 51-80; deliberate sampling for heterogeneity	Interviews; Grounded theory	Long-term goals and active involvement in the intervention related to greater adherence.	Exercise No uptake-maintenance distinction.

Table 3.1 Study characteristics

Table 3.2 Appraisal of studies

	Campbell et al. (2001)	Fiskin et al. (2015)	Hammer et al. (2015)	Hendry et al. (2006)	Kabel et al. (2014)	Kaptein et al. (2013)	Petursdottir et al. (2010)	Stone and Baker (2015)	Thorstensson et al. (2006)	Veenhof et al. (2006)
CASP Qualitative Checklist	6/10	6/10	6/10	9/10	6/10	7/10	9/10	9/10	7/10	6/10
1. Was there a clear statement of the aims of the research?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Is a qualitative methodology appropriate?	✓	✓	✓	✓	✓	✓	✓	✓	✓	?
3. Was the research design appropriate to address the aims of the research?	?	✓	✓	✓	?	x	✓	✓	?	?
4. Was the recruitment strategy appropriate to the aims of the research?	✓	?	✓	✓	✓	✓	✓	✓	?	✓
5. Was the data collected in a way that addressed the research issue?	✓	?	x	✓	?	✓	✓	✓	?	✓
6. Has the relationship between researcher and participants been adequately considered?	?	?	x	✓	?	x	✓	?	✓	?
7. Have ethical issues been taken into consideration?	?	✓	✓	?	✓	✓	?	✓	✓	✓
8. Was the data analysis sufficiently rigorous?	?	?	?	✓	?	?	✓	✓	✓	✓

9. Is there a clear statement of findings?		✓	✓	?	✓	✓	✓	✓	✓	✓	✓
10. How valuable is the research?		✓	✓	✓	✓	✓	✓	✓	✓	✓	?
Trustworthiness	Credibility	✓		✓	✓	✓	✓	✓	✓	✓	✓
	Transferability	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Dependability								✓	✓	
	Confirmability	✓	✓	✓	✓		✓	✓	✓	✓	✓

✓= yes, x= no, ?= uncertain

Table 3.3 Barriers and facilitators: Themes, subthemes and number of supporting references

Domain	Major themes	Barriers	No of studies	No of ref/ces	Facilitators	No of studies	No of ref/ces
Physical health		Physical barriers and limitations (Pain and other symptoms; Perceived functional limitations)	9	94	PA for mobility, symptom relief and health (PA to maintain mobility; PA for symptom relief; PA for health)	9	34
Intrapersonal /psychological factors	Experience and beliefs about PA and OA	PA as non-effective, harmful or of doubtful effectiveness	6	36	Exercise as beneficial	7	60
		OA beliefs	5	17	Knowledge about exercise	3	8
	Behavioural regulation and attitude	Resigned to OA	5	10	Keep going despite OA	7	18
		Lack of motivation	6	14	Adjustments, prioritisation and personal effort (Adjusting PAs; Prioritising PA; Personal responsibility and effort in being physically active)	9	41
		Lacking behavioural regulation	4	23			
	Emotions	OA-related distress	6	23	Enjoyment	4	22
Social Environment	Health professionals	Lack of advice and encouragement from health professionals	5	22	Support from health professionals	8	50
	Social support	Social comparison as demotivating	5	15	Social support facilitating PA	7	43
		Lack of social support	4	8			

1. Physical health

Barriers. Physical barriers and limitations. Pain is aversive, stressful and inherent to living with OA (Campbell et al., 2001; Fiskén et al., 2015; Hammer et al., 2015; Hendry et al., 2006; Kabel et al., 2014; Kaptein et al., 2013; Petursdóttir et al., 2010; Stone and Baker, 2015; Thorstensson et al., 2006). It was mentioned as part of daily experience (Petursdóttir et al., 2010; Stone and Baker, 2015) or in relation to particular types of activities (Fiskén et al., 2015; Hammer et al., 2015; Hendry et al., 2006; Kaptein et al., 2013; Stone and Baker, 2015; Thorstensson et al., 2006). Along with fatigue and stiffness (Kaptein et al., 2013; Petursdóttir et al., 2010; Stone and Baker, 2015) these symptoms hindered the ability to engage in PA. There was a vicious cycle between symptoms and lack of exercise (Hammer et al., 2015; Hendry et al., 2006). At an advanced stage of OA, PA was inhibited (Hendry et al., 2006). OA symptoms were aggravated by obesity and made PA more difficult (Campbell et al., 2001; Hendry et al., 2006; Petursdóttir et al., 2010). Participants also discussed their sense of limited physical capacities and that one's body cannot manage PA requirements, resulting in loss of previous activity patterns (Hendry et al., 2006; Kabel et al., 2014; Kaptein et al., 2013; Petursdóttir et al., 2010; Stone and Baker, 2015). For example, some talked about the need to choose between activities because of limited energy (Kaptein et al., 2013). Old age and lack of physical fitness were also reported as perceived PA barriers (Hendry et al., 2006; Petursdóttir et al., 2010).

Facilitators. PA for mobility, symptom relief and health. Among those who held a physically active lifestyle maintaining or regaining their mobility was a strong motive for PA (Campbell et al., 2001; Hammer et al., 2015; Petursdóttir et al., 2010; Stone and Baker, 2015; Veenhof et al., 2006). In most cases the aim was to keep functioning (Campbell et al., 2001; Hendry et al., 2006; Kaptein et al., 2013; Thorstensson et al., 2006), in some it was so specific as to prevent joint surgery (Hammer et al., 2015; Veenhof et al., 2006). Pain relief is another

strong motive for being physically active and active individuals were more likely those who had experienced pain reduction (Campbell et al., 2001; Hammer et al., 2015; Petursdottir et al., 2010; Stone and Baker, 2015; Veenhof et al., 2006). A few informants presented a “no pain, no maintenance” pattern, where pain cessation was followed by dropping exercise (Campbell et al., 2001; Veenhof et al., 2006). Improvements in other symptoms, such as stiffness and joint stability, were sufficient reasons for being active, even when pain remained (Campbell et al., 2001; Petursdottir et al., 2010). Maintaining good general health and physical condition were also reasons for being physically active (Hammer et al., 2015; Hendry et al., 2006; Kaptein et al., 2013; Petursdottir et al., 2010; Thorstensson et al., 2006). This facilitator was closely linked to a positive, beneficial PA experience and subsequent positive attitude towards PA, which is a crucial facilitator discussed below.

2. Intrapersonal/ psychological factors

Experience and beliefs about exercise

Facilitators. Exercise as beneficial. Experiencing benefits from exercise participation, which in most of the studies was related to engagement in an exercise intervention, helped shaping positive beliefs and motivated individuals towards continuing exercise (Campbell et al., 2001; Fiskén et al., 2015; Hammer et al., 2015; Hendry et al., 2006; Petursdottir et al., 2010; Thorstensson et al., 2006; Veenhof et al., 2006). A sense of psychosomatic well-being was an important component of this theme (Fiskén et al., 2015; Hammer et al., 2015; Hendry et al., 2006; Petursdottir et al., 2010; Thorstensson et al., 2006). Improvement in coping with OA (Thorstensson et al., 2006) and sleep (Petursdottir et al., 2010) were mentioned.

Knowledge about exercise in OA. Accurate knowledge of the importance of exercise in OA, acquired through health care, physiotherapy and exercise interventions, was an important

facilitator (Hammer et al., 2015; Petursdottir et al., 2010; Stone and Baker, 2015; Thorstensson et al., 2006). It led to awareness regarding exercise benefits and helped in making correct interpretations of exercise experiences.

Both the above themes emerged from exercise-focused studies only.

Barriers. PA as non-effective, harmful or of doubtful effectiveness. The belief that PA does not help or might further deteriorate their condition, hindered people from being active (Campbell et al., 2001; Hammer et al., 2015; Hendry et al., 2006; Kaptein et al., 2013; Stone and Baker, 2015; Thorstensson et al., 2006). Experiencing activity-related pain in the joint, for example, was often interpreted as PA exacerbating OA, which stemmed from the understanding of OA as a “wear and tear” condition (Hendry et al., 2006; Kaptein et al., 2013; Thorstensson et al., 2006). Not experiencing the anticipated beneficial effects during exercise interventions was a reason for distrust in PA as an effective means of treatment (Campbell et al., 2001; Hammer et al., 2015; Hendry et al., 2006; Thorstensson et al., 2006). Also, early negative experiences with sports resulted in exercise avoidance (Petursdottir et al., 2010).

OA beliefs. Beliefs that nothing can be done regarding the condition (Hendry et al., 2006; Petursdottir et al., 2010; Thorstensson et al., 2006) and that overuse was the cause of OA (Campbell et al., 2001; Hendry et al., 2006; Kaptein et al., 2013) were linked to less inclination towards being physically active. In one study the relationship between PA and OA was discussed as bi-directional (Kaptein et al., 2013). These beliefs were mostly reported in exercise-focused studies (four exercise studies with one PA-focused study also revealing such beliefs).

Daily activities as PA. This theme revolved around beliefs about non-leisure PA (Hendry et al., 2006; Kaptein et al., 2013; Petursdottir et al., 2010; Thorstensson et al., 2006).

However, there were no consistent patterns across studies to be clearly classified as barriers or facilitators. For example, non-leisure activities were viewed as a sufficient amount of PA by some (Hendry et al., 2006; Petursdottir et al., 2010; Thorstensson et al., 2006) and as insufficient by others (Hendry et al., 2006).

Behavioural regulation and attitude

Facilitators. Keep going despite OA. Authors' interpretations related to this concept varied, e.g. determination to take control of arthritis (Hendry et al., 2006), perseverance (Thorstensson et al., 2006), personality traits of adaptability and initiative (Petursdottir et al., 2010), belief that there are “things patients can do” about their OA (Campbell et al., 2001), motivation towards long-term goals (Veenhof et al., 2006). The importance of keeping a positive attitude was also discussed (Kaptein et al., 2013; Petursdottir et al., 2010). In two studies the relevant participant quotes were presented under the themes “risking embarrassment” (Kabel et al., 2014) and “bi-directional impact between PA and arthritis” (Kaptein et al., 2013).

Adjustments, prioritisation and personal effort. Physically active individuals described how they were making short or long term modifications to their PA (Fisken et al., 2015; Hammer et al., 2015; Hendry et al., 2006; Kabel et al., 2014; Kaptein et al., 2013; Petursdottir et al., 2010), such as finding a type of exercise that was suitable for their physical abilities (Fisken et al., 2015; Hammer et al., 2015; Hendry et al., 2006; Petursdottir et al., 2010), adjusting PA intensity to their current condition (Hammer et al., 2015; Kabel et al., 2014; Petursdottir et al., 2010), even changing their job (Kaptein et al., 2013). This task of continuously adjusting PAs was quite demanding (Petursdottir et al., 2010). Prioritising PA and fitting it into a routine was mentioned by a number of physically active participants and reflected the importance they assigned to PA (Campbell et al., 2001; Hendry et al., 2006;

Thorstensson et al., 2006; Veenhof et al., 2006). Active participants also acknowledged they were the main agents in managing their condition and they were consciously making efforts to stay active (Campbell et al., 2001; Hendry et al., 2006; Kaptein et al., 2013; Thorstensson et al., 2006).

Barriers. Lack of motivation. Participants in different studies referred to a lack of motivation or goal, laziness and boredom towards exercise (Campbell et al., 2001; Hammer et al., 2015; Hendry et al., 2006; Petursdottir et al., 2010; Thorstensson et al., 2006; Veenhof et al., 2006). These type of barriers were reported in the exercise-focused studies only and were not further explored.

Lacking behavioural regulation. In the face of the demands of other life roles and a busy schedule, especially family related, inactive participants were not prioritising PAs (Campbell et al., 2001; Hendry et al., 2006; Kaptein et al., 2013; Thorstensson et al., 2006). In two studies informants referred to not finding a PA suitable for their current condition (Fisken et al., 2015; Hendry et al., 2006). In one study low self-regulation was the reason given for not exercising regularly (Hendry et al., 2006).

Resigned to OA. In half of the studies informants expressed a resigned attitude towards making an effort to be active (Campbell et al., 2001; Hendry et al., 2006; Petursdottir et al., 2010; Stone and Baker, 2015; Thorstensson et al., 2006). Reflecting fatalistic beliefs about OA and feelings of helplessness, this attitude was linked to attenuated motivation for being physically active.

Emotions

Facilitators. Enjoyment. Enjoying exercise in general or a particular type of exercise facilitated its continuation (Fisken et al., 2015; Hendry et al., 2006; Petursdottir et al., 2010). This facilitator of engagement emerged in the exercise-focused studies only.

Barriers. OA related distress. Living with OA means adjusting to a reality of decreased physical functioning and in several cases participants talked about this experience of giving up activities, being unable to meet life roles and daily demands as distressing or embarrassing (Campbell et al., 2001; Hammer et al., 2015; Kabel et al., 2014; Kaptein et al., 2013; Petursdottir et al., 2010; Stone and Baker, 2015). Mental stress (Hammer et al., 2015), extreme unhappiness and paralyzing fatigue (Petursdottir et al., 2010), feeling broken and mentally depressed (Stone and Baker, 2015), weakness (Kaptein et al., 2013) were used.

3a. Social Environment

Health professionals

Facilitators. Support from health professionals. Physiotherapists exerted great influence on the patients' PA/ exercise habits (Campbell et al., 2001; Hammer et al., 2015; Hendry et al., 2006; Petursdottir et al., 2010; Stone and Baker, 2015; Veenhof et al., 2006). Providing instructions, education, encouragement and rapport with the patient were means of facilitating exercise. Advice and prescription by doctors was another facilitator (Hendry et al., 2006; Petursdottir et al., 2010). Supervision during exercise was valued (Campbell et al., 2001; Fisken et al., 2015; Hammer et al., 2015; Hendry et al., 2006; Thorstensson et al., 2006; Veenhof et al., 2006). Good supervision gave participants the reassurance that what they were doing was appropriate and good for their body (Hendry et al., 2006), which they needed (Stone and Baker, 2015), and motivated them to exercise (Campbell et al., 2001; Hammer et al., 2015;

Thorstensson et al., 2006; Veenhof et al., 2006). Support from health professionals was reported in four exercise studies and one PA-focused.

Barriers. Lack of support from health professionals. Ambiguous, no or conflicting information from doctors regarding PA was a barrier (Campbell et al., 2001; Hendry et al., 2006; Petursdottir et al., 2010; Stone and Baker, 2015). In one study, the instructor not having specialised OA training was the reason that lead participants to discontinue their exercise (Fisken et al., 2015).

Social support

Facilitators. Social support facilitating PA. Social support as a facilitator was mainly discussed in the context of exercising in a group, as well as support from family and friends. Feeling comfortable and motivated, even inspired when exercising with people of similar physical abilities and age emerged as an advantage of PA programs (Campbell et al., 2001; Fisken et al., 2015; Hammer et al., 2015; Hendry et al., 2006; Kaptein et al., 2013; Stone and Baker, 2015). This was of particular importance when someone was first introduced to PA (Hammer et al., 2015). Opportunities to socialise were also an advantage of group PA (Fisken et al., 2015; Hendry et al., 2006). In addition, psychological and instrumental support from family and friends emerged as an asset of physically active participants, taking the form of active encouragement, expression of interest and understanding, an exercise buddy or role model (Hammer et al., 2015; Kaptein et al., 2013; Petursdottir et al., 2010; Stone and Baker, 2015). Community based support was mentioned as PA promoting (Stone and Baker, 2015). This theme stemmed equally from exercise and PA centered studies, although the focus of the former was on group exercise and the latter on important others' support for an active lifestyle.

Barriers. Social comparison as demotivating. Although this concept did not explicitly appear as an authors' interpretation it emerged from informants' quotes. Being unable to keep up with others when participating in PA was a PA barrier as it provoked feelings of embarrassment and distress (Campbell et al., 2001; Fiskén et al., 2015; Hammer et al., 2015; Hendry et al., 2006; Kabel et al., 2014). This barrier was reported in four exercise studies and one PA-focused. *Lack of social support* The lack of social support from peers and family as a barrier was discussed in relation to lack of understanding and encouragement from the person's family and social (Campbell et al., 2001; Kaptein et al., 2013; Petursdottir et al., 2010) and work environment (Kaptein et al., 2013).

3b. Physical Environment

Barriers. The cost of exercise classes (Fiskén et al., 2015; Kaptein et al., 2013; Petursdottir et al., 2010), limited accessibility (Petursdottir et al., 2010; Thorstensson et al., 2006) and lack of availability of appropriate modes (Petursdottir et al., 2010; Stone and Baker, 2015), as well as cold weather and issues regarding safety (Fiskén et al., 2015) were the reported environmental barriers to PA.

Discussion

This SR is the first to synthesise the existing qualitative research on barriers and facilitators to PA in knee and hip OA. Pain and physical limitations, absence of positive PA experiences and beliefs, resigned attitude and distress due to OA, lack of behavioural regulation, lack of support from health professionals and negative social comparisons when exercising in a group were important PA barriers. Symptom relief and mobility, positive exercise experiences and beliefs, knowledge, enjoying exercise, a "keep going" attitude, adjusting and prioritising PA, having professional and social support were important PA

facilitators. Overall the findings are consistent with known PA correlates in exercise psychology (Biddle and Mutrie, 2008), theories of behavioural change (Kwasnicka et al., 2016) and results emanating from existing SRs in general (i.e. non-OA specific) populations that share common characteristics with OA patients (Franco et al., 2015; Morgan et al., 2016; Rhodes and Quinlan, 2015). Present findings also outline a unique profile of PA barriers and facilitators in lower limb OA.

Factors related to physical health, specifically pain and physical function, were the most consistently reported. This indicates that OA has a central role and impact in people's lives and experiences, which is in line with previous qualitative findings that pain discussions by people with OA differ in frequency and quality in comparison to healthy individuals (Gignac et al., 2006). Importantly, physical barriers are reported both by active and inactive people. Therefore, physical barriers alone cannot explain PA behaviour- with the exception of patients at very advanced stages of OA (Liu et al., 2016). Intrapersonal and social variables are crucial in PA behaviours reported earlier (Rhodes and Quinlan, 2015).

The identified barriers and facilitators are not stand-alone and independent entities, but manifest a complex interplay. Personal experience, knowledge and beliefs about PA, exercise and OA were interwoven concepts and formed the basis of PA behaviour. Experiencing benefits from participation in an exercise program- which was the case in most of the included studies- shapes a positive attitude towards PA (Franco et al., 2015; Horne and Tierney, 2012; Morgan et al., 2016; Peeters et al., 2015; Wilcox et al., 2006). Accurate knowledge regarding PA, exercise and OA bolstered a positive interpretation of and predisposition towards PA experience. Viewing pain as manageable versus inevitable elicited different behaviours (Main and Williams, 2002; Ross et al., 2001) and, not surprisingly, patient education is a core component of health care and OA management (Larmer et al., 2014; NICE, 2014). Support

from health professionals becomes crucial as they can provide rationale and motivation for PA (Horne and Tierney, 2012) and shape the patients' health experience (Gignac et al., 2006). The above factors and available social support are not independent from, but influence motivation, attitude and behavioural regulation.

Most of the PA barriers and facilitators emerged under the psychological/intrapersonal domain and were mostly OA-related. The data analysis allowed for new insights into the original studies, such as the emerging theme of OA-related distress and two distinct patterns in attitude, beliefs, motivation and behavioural regulation- one facilitating and the other hindering PA. Pain and its multifaceted impact is a source of distress in OA (Hawker et al., 2008). In turn, anxiety and depressive symptoms, which are more prevalent in people with arthritis (He et al., 2008), are predictors of poorer function (Dekker et al., 1992; Sharma et al., 2003) and pain (de Rooij et al., 2014; Edwards et al., 2016; Somers et al., 2009; Volders et al., 2015). Still cognitive processes underlying the distinct patterns are missing, e.g. what distinguishes those who, for a given level of structural disease-severity and OA-related pain, exhibit a positive attitude and behavioural regulation from those who are resigned, cope ineffectively with OA-stress and lack self-regulation? Explanations involving distinguishing processes and participant characteristics might lie in theoretical frameworks of behaviour change and health, which are absent in the included studies, with one exception (Hammer et al., 2015). For example, self-efficacy, self-determination and need satisfaction are precursors of behaviour in theories which have been applied to predicting and promoting PA (Bandura, 1977; Deci and Ryan, 2008), whereas sense of control is a common concept in the stress and coping literature (Jensen et al., 1991). Future research should make use of theoretical knowledge and approaches to enable targeted and more effective research and interventions (Michie, 2008).

All the findings reported were grounded in the three studies that scored “high” at both sets of quality criteria (Hendry et al., 2006; Petursdottir et al., 2010; Stone and Baker, 2015), along with the seven medium quality studies, which confirms their trustworthiness. However, aspects of methodology were poorly reported or explored in the selected studies, particularly those of medium quality. A consideration of the researcher-participant relationship and employing an external auditor for the decision trail (dependability) should be used to increase confidence in the findings.

The SR findings hold implications for clinical practice. All healthcare professionals who manage people with lower-limb OA have a key role in facilitating PA through their advice, attitude towards OA and decision to seek multidisciplinary input e.g. from physiotherapy. Even without directed advice to increase PA, health and condition-related advice and a supportive stance from healthcare professionals can influence decisions related to PA engagement (Horne et al., 2010). In the absence of education, people with OA tend to draw from lay and often fatalistic beliefs of PA and exercise in OA. An individual assessment of the experienced impact of pain and disability, personal attitudes and circumstances, educating about the role of PA in OA management, offering feasible yet specific PA prescription and encouragement can have an impact on the persons’ PA and exercise behaviour. Pain and stress-related coping strategies, guidance through exercise prescription and effective communication are the main components of established arthritis self-management programs (Lorig et al., 1993). Increasing the time designated to each patient within the health care system could allow for such practices to take place. Counselling referral and online educational tools could also affect PA behaviour.

Based on the available qualitative evidence it was not possible to adequately explore the secondary SR questions, an issue which has been previously reported (Koeneman et al., 2011; Rhodes and Quinlan, 2015). Only three studies focused on lifestyle PA, which is

surprising considering the paradigm shift in the health literature from exercise promotion to a combination of PA promotion and sedentary time reduction (Katzmarzyk, 2010). Also, only one study made the distinction between PA uptake and maintenance, despite the recognition that these two stages entail different determinants (Deci and Ryan, 2008; Kinnaefick et al., 2014; Prochaska and DiClemente, 1983). In the case of people living with OA, the factors and processes leading to uptake and maintenance of overall PA need to be further explored and understood.

This SR has applied rigorous methods and provides an in-depth and meaningful understanding of the phenomenon of interest based on the accumulated existing qualitative evidence, thus moving one step forward from existing SRs (Stubbs et al., 2015; Veenhof et al., 2012). Gaps in the existing literature were also identified. With regards to data synthesis, coding participants' quotes and authors' interpretations separately allowed aspects of the phenomenon not captured by the original studies to come to light. During data synthesis, peer review by a multidisciplinary team took place to enhance credibility. The main reviewer's background is clinical psychology, which might be reflected in the emphasis on the "psychological" component of PA barriers and facilitators.

There are certain limitations to this study. The majority of the included studies were exercise-focused, therefore might not accurately or fully represent barriers and facilitators to lifestyle PA (of which engaging in structured exercise programs is type or form). Due to resource limitations, studies not written in English were excluded. Two relevant studies were also excluded because they were in a conference abstract form and additional data were not available (Gay, 2015; Jinks et al., 2015). Lastly, due to the nature of the evidence, directions of the relationships and interactions among the identified factors cannot be drawn.

In summary, there is a complex interplay among the physical, intrapersonal, psychological and socio- environmental barriers and facilitators of exercise and PA that bears similarities with other chronic diseases, but also includes characteristics specific to OA. Personal experiences, beliefs, attitudes and emotions, as well as the social environment, i.e. health care and social support, are dynamic factors shaping PA behaviour. Considering that OA becomes more prevalent with age, it is important and challenging to make sustained lifestyle changes that will have a positive impact on an individual, as well as at a health-care system level. With the aim of identifying effective practices to help people with OA become more active, future research should involve behavioural intervention studies to address the factors identified above.

Amendments to the protocol

Confidence in the synthesised findings was not used due to ambiguities in the suggested process (ConQual; Munn et al., 2014), i.e. regarding transparency and satisfactory justification of the assessment outcome. However, the studies-sources of each finding were checked. The three studies scoring “high” quality at both sets of criteria informed *all* themes, along with the medium quality studies.

Kappa statistic was not measured. The two researchers run the searches independently for all databases following the Medline search strategy. Because of differences in operators and options at different search engines, the number of studies differed at the stages preceding study selection. Each reviewer’s full text selection stage was updated by the other researcher’s findings. At this stage agreement was met for all included studies.

Footnotes

Contributors Study concept and design: JLD, AR, AMK, RK, AbA, NE. Searches: AMK, AsA. Study appraisal: AMK, NE. Data analysis: AMK, checked by NE. Data interpretation: AMK, checked by JLD, AR, NE. Manuscript draft: AMK. Manuscript review and input: JLD, AR, AbA, NE, RK. All authors provided feedback and approved the final draft.

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Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Qualitative synthesis level electronic data (NVivo V.11) are available upon request from the corresponding author.

Epilogue

The SR was published in BMJ Open in 2017. Close to the completion of this thesis, in June 2019, it was deemed appropriate to review any recent literature and its relevance to the SR findings so as to provide an up-to-date account of the topic.

A search was conducted covering the interim period (01/01/2016-01/08/2019). The same exhaustive search keyword combinations as in the original review in the databases MEDLINE, Embase, PsychInfo. The search yielded 5.661 titles. After removing duplicates, 4.427 titles or/ and abstracts were screened. Thirty-four articles were assessed for eligibility and five studies were considered as meeting the specified criteria (figure 3.2 for a study selection flow diagram). Three of the studies were focusing on exercise programs (Danbjorg et al., 2018; Lee et al. 2016; Wallis et al. 2019) and two on overall physical activity (Darlow et al., 2018; Gay et al. 2018). Study characteristics can be found in Table 3.4.

Given that all themes of the existing SR were grounded on high quality studies, to examine whether the suggested framework is applicable to the new studies a top-down approach for data analysis was adopted. Specifically, the results section of the five studies (themes and authors' interpretations) was mapped under the themes of the SR. The existing themes covered the data and no new themes were generated.

In conclusion, the number of eligible studies that were published in a period of less than three years demonstrates a marked research interest in the area of PA in OA. Still the research focus is more on exercise therapy and exercise interventions and less on lifestyle PA promotion. Importantly, identifying newly published qualitative studies and mapping the respective findings under the existing SR framework, provided support that the present SR

offers a comprehensive framework for understanding PA barriers and facilitators in hip and knee OA.

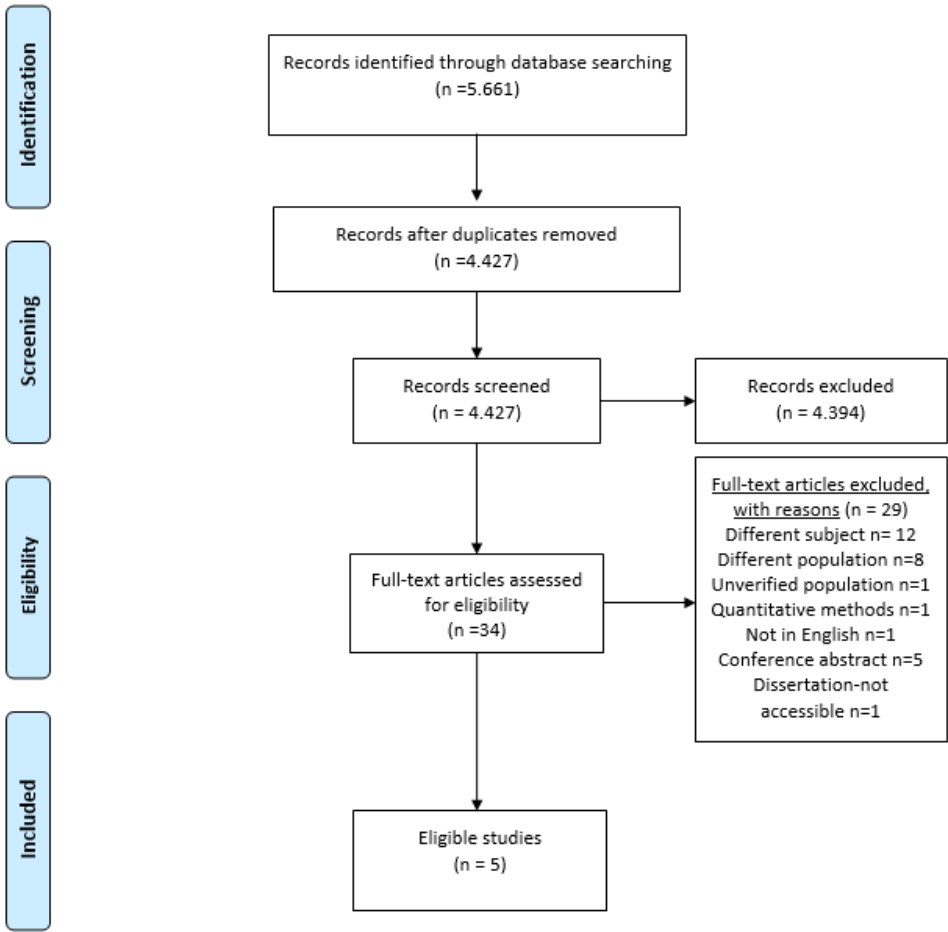


Figure 3.2 Study selection PRISMA flow diagram- update

Table 3.4 Study characteristics for eligible studies published between 01/2016- 07/2019

Study	Objectives	OA Site	Participants and setting	Methods (Data collection and analysis)	Findings (Themes)	Relevance to Secondary SR Objectives	Relevance to SR themes
Danbjorg et al. (2018)	Identify mental and physical barriers, motivational and social aspects of training at home. [Test and enhance an exercise App for home use]	Hip, knee	6 participants, Slagelse municipality clinical care settings Denmark	Focus group Malterud's systematic text condensation	Competition as motivation Training together Barriers (motivation)	Exercise (Exercise App) No uptake-maintenance distinction.	Enjoyment Social support as facilitating PA PA as beneficial PA for symptom relief Adjustments, prioritisation Lack of motivation Lack of social support
Darlow et al. (2018)	Explore beliefs about OA, particularly how these were formed and what impact they had on PA participation, health behaviour and self-management.	Knee	13 participants GP practices, community physiotherapy clinics, public adverts New Zealand	Interviews, Interpretive Description	Knowledge: certainty and uncertainty -structural model of degeneration -approaches to OA management Living with OA -the big picture -living with OA is a balancing act	PA No uptake-maintenance distinction.	PA as beneficial PA as harmful Physical barriers PA for mobility and symptom relief Keep going despite OA Resigned to OA Adjustments Lack of support from HP
Gay et al. (2018)	Explore motivators and barriers to regular PA	Knee	20 participants Spa therapy resorts France	Interviews Thematic analysis	PA definition PA with knee OA Physical and psychological well-being Lifestyle Social relationship Environment Pain and OA Intrinsic barriers	PA No uptake-maintenance distinction.	PA as beneficial Adjustment Physical barriers and limitations Enjoyment Social support as facilitating PA Keep going attitude Physical environment

					Extrinsic barriers		
Lee et al. (2016)	Explore perceptions and experience of exercise in older people with knee OA	Knee	31 participants ≥60 years Community center for older people Hong Kong	Interviews Content analysis [mixed method study]	Satisfaction with the program. Mastering of exercise movements. Experience of exercise effects. Integration of exercises to the daily routine.	Exercise program No uptake-maintenance distinction.	PA as beneficial Enjoyment Social support from HP Adjustments, prioritisation
Wallis et al. (2019)	Explore perceptions about participating in a walking program in people with severe kOA and increased CVD risk (benefits, adherence, view of program)	Knee	23 participants Metropolitan health service OA hip and knee clinic Australia	Interviews Not reported (“Qualitative data analysis”)	Main theme: My knee is damaged and needs replacing Subthemes: Functional, psychological and social benefits Supervision, monitoring, commitment Weather, environment and other health concerns	Walking program (exercise/ PA) No uptake-maintenance distinction.	Physical barriers OA beliefs PA as beneficial Adjustments, prioritisation, personal effort Social support facilitating PA Physical environment

OA=osteoarthritis; SR= systematic review; PA=physical activity; GR=general practitioner; HP=healthcare professional; kOA=knee

osteoarthritis; CVD=cardiovascular. Secondary objectives refer to the distinction between exercise-lifestyle PA and uptake-maintenance.

CHAPTER 4

METHODS FOR A CROSS-SECTIONAL, QUANTITATIVE STUDY ON PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR CORRELATES IN HIP AND KNEE OSTEOARTHRITIS

The present chapter presents the design, setting, procedures and measures characterising and employed within a multicentre, cross-sectional, quantitative study involving accelerometer and self-reported assessments. The variables assessed via questionnaire were aligned with and pulled from the findings of the two subsequent chapters. Methods on data analyses relevant to the specific research questions addressed in each chapter are presented within chapters 5 and 6.

Ethics approval

The study received ethical approval from the West Midlands Research Ethics Committee (16/WM/0371) and Health Research Authority (IRAS ID 19880). The study was also adopted by the NIHR Portfolio (Central Portfolio Management System ID 31488) (Appendix 4.1 for letters of ethics approval).

Setting and procedures

Participants with hip or knee OA were recruited from (a) secondary health care, in particular outpatient Orthopaedic and Orthopaedic Assessment Clinics at Dudley Group of Hospitals NHS Trust (Dudley NHS), Nottingham University Hospitals NHS Trust (NUH), Solent NHS Trust (Solent NHS); b) a group of older adults affiliated with the university of Birmingham (UoB) (that is, they participate in educational programmes and research), the 1000 Elders; (c) from the UoB as a work place. Recruitment was done in multiple ways depending on the recruitment site: face-to-face (Dudley NHS, Solent NHS), by mail (NUH), email (1000 Elders) or online/ poster advertisement (UoB, Dudley NHS) (Appendix 4.2 for advertisement poster and invitation letter).

In face-to-face recruitment, the health-care professional (HCP), specifically consultant or physiotherapist, introduced the study to eligible patients. Further information was provided to interested participants by the researcher or HCP. Patients who expressed their interest in

taking part and gave verbal consent to be contacted, were given the Patient Information Sheet (PIS; appendix 4.4). Next, the researcher made a telephone contact leaving a time window of at least 24 hours to confirm willingness to participate, answer potential questions and book an appointment. In mail recruitment (NUH), members of the healthcare team screened the patient list and mailed an invitation and the PIS to eligible patients. In all non-face-to-face recruitment, interested participants would contact the researcher themselves for any questions and to book an appointment. For non-screened participant invitations (email, advert), screening was done by the researcher upon this telephone contact expressing interest in the study.

Data collection took place at the same site as recruitment. During the appointment, participants filled in a questionnaire pack in the presence of the researcher (appendix 4.3 for the questionnaire pack and consent form). The questionnaires administered during each hospital visit assessed aspects of physical health, psychological health, potential psychosocial and physical environmental determinants of PA and SB, with reference to the past week or two weeks. Assessments of height, BMI and body composition (bio-electrical impedance analysis) were undertaken. A test of physical function, the 20-meter timed walk test (Osteoarthritis Society Research, 1996), was also conducted. Participants were then given the GT3X accelerometer (ActiGraph®), verbal and hands-on use instructions and an accelerometer log book to take home. The log book requested details on the exact times the accelerometer was put on/ took off for each day of the wear week. Participants were reimbursed for travel expenses (up to £10). Accelerometers were sent back to the research team by post, using a pre-paid envelope.

Potential sources of bias considered for this study were bias related to selection, in particular response (systematic differences between those who volunteered to participate and those who declined), and information bias related to providing valid data in the measures used

(Vandenbroucke et al., 2007). The former was addressed by involving the patient's healthcare team in the face-to-face recruitment process as a means of increasing patients' motivation for participation. In particular the consultant or other health-care professional following the consultation briefly introduced the study and asked patients whether they would be interested to find out more. To address information bias, it was made clear by the researcher that the research project is independent of their healthcare provision and confidentiality is ensured. Also, data collected were not considered sensitive and the researcher aimed to establish a positive climate with the participants before data collection took place.

Participants

Inclusion criteria. Eligible participants were adults above 40 years of age with a physician-made diagnosis of hip or knee OA regardless of radiographic evidence (confirmed by the healthcare professional (HCP) or stated in the patient's file).

Exclusion criteria. Patients were excluded if they used aids other than a walking stick to ambulate; if they had a diagnosis (self-reported) of other forms of arthritis such as rheumatoid arthritis, fibromyalgia, lupus, (active) gout; if they had a diagnosis (self-reported) of any mental disorder that causes significant memory loss, e.g., Alzheimer's disease and vascular dementia.

Measures

The selection of the PA- and ST- related variables was informed by the systematic review findings (chapter 3). Indicators of all the major types of PA determinants (barriers and facilitators), namely physical health, psychological/ intrapersonal, social and physical environment, categorized under the Biopsychosocial model of health, are represented in the quantitative measures presented below (illustrated in figures 4.1 and 4.2). PA variables (LPA, ST, total and bouts MVPA), were included in the analysis as daily average in minutes/ hours

(aims 1a, 2) and binomial variable of meeting or not MVPA guidelines (aim 1b). In the bivariate correlations tested for Aim 3, total/ bouted MVPA was defined as percentage of total wear time, to account for wear-time as a confounder, and outcomes of interest were physical function, BMI, joint activities of daily living, joint pain, physical and psychological QoL, anxiety and depressive symptoms.

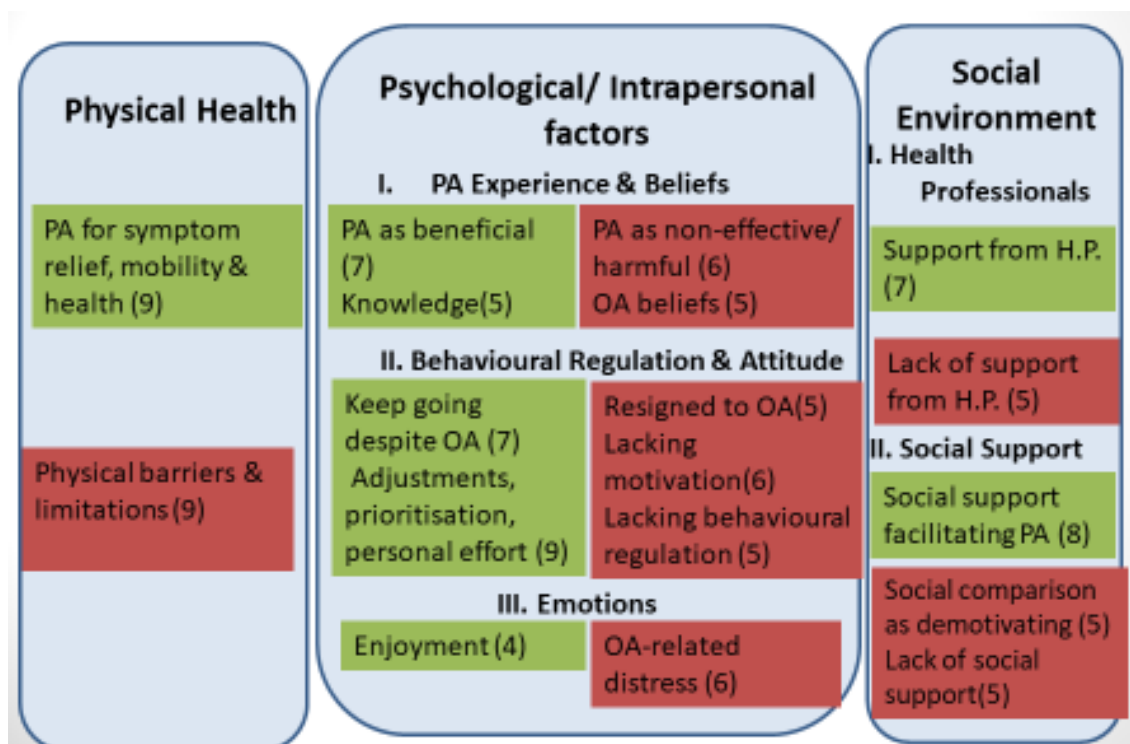


Figure 4.1 Summary of the systematic review findings (chapter 3)

PA barriers and facilitators are presented under the relevant domain of the Biopsychosocial model of health. Number of sources (primary studies) supporting each theme are reported in parentheses. Physical-environmental factors were limited and have been omitted from the figure. PA= physical activity; OA=osteoarthritis; HP= healthcare professional

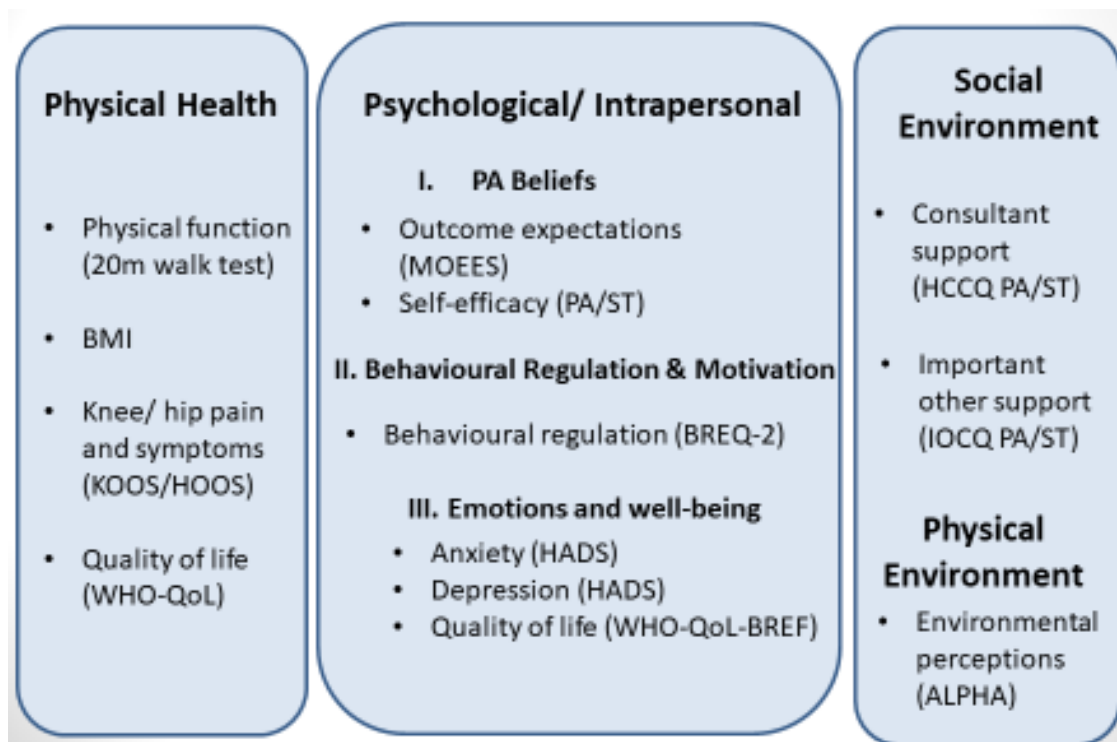


Figure 4.2 Summary of physical activity and sedentary time correlates assessed in the quantitative study

Physical activity (PA) / sedentary time (ST) correlates and their operationalisation (reported in parentheses) are presented under domains of the Biopsychosocial model and correspond to the barriers and facilitators depicted in Figure 4.1. BMI= body mass index; KOOS/ HOOS= Knee/ Hip Injury and Osteoarthritis Outcome Score; WHO-QoL/ WHO-QoL BREF= World Health Organisation Quality of Life assessment; MOEES= Multidimensional Outcome Expectations for Exercise Scale; BREQ-2= Behavioural Regulation in Exercise Questionnaire-2; HADS= Hospital Anxiety and Depression Scale; HCCQ= Health-Care Climate Questionnaire; IOCQ= Important Other Climate Questionnaire; ALPHA= Assessing Levels of Physical Activity questionnaire.

Objective measures

Objectively measured PA and ST. GT3X Actigraph accelerometers were used to objectively assess PA and ST over a seven-day period. The Actigraph GT3X+, and its newest generations of wGT3X and wGT3X-BT, are lightweight (27g) and compact (3.8 x 3.7 x 1.8cm) activity monitors that record accelerations in g's for 3 axis (horizontal, vertical, perpendicular). The raw data are sampled in user-selected frequencies (30-100Hz) and sample rate (in seconds). Raw data are available for each of the 3 axes separately and combined (i.e., vector magnitude=square root of the sum of the 3 squared axes). Raw data are accumulated in epochs and further processed through the ActiLife Data analysis software. Epochs are screened to distinguish valid days, wear and non-wear, PA intensity, sedentary time, bouts or total activity according to certain parameters selected by the researcher.

In the present study, the default 30Hz frequency and 1s sample rate were applied for data recording and 60s epochs were used for data analysis. Participants were instructed to wear the accelerometer on their right hip (Ellis et al., 2014) during waking hours for 7 consecutive days. Individual accelerometer data were considered valid when wear time was 10 or more hours per day for a minimum of 4 days (including at least one weekend day) during the 7-day period (Troiano et al., 2008). Wear and non-wear time distinction was based on Choi et al. (2011) criteria, in particular 90 minutes or more of consecutive 0 counts allowing for up to 2 minutes spike tolerance (with a window of 30 minutes of 0 counts before/ after the spike). Two different sets of cut points were used for PA/ST classification: (1) based on the vertical axis counts, Troiano et al. (2008) cut points of 0-99, 100-2019, 2020-5998, 5999 or more cpm classified ST, LPA, MPA and VPA, respectively; (2) based on vector magnitude Santos-Lozano et al. (2013) and Aguilar-Farias et al. (2013) cut points of 0-199, 200-2750, 2751-9358, 9358 or more cpm classified ST, LPA, MPA and VPA, respectively. MVPA corresponds to MPA

plus VPA time. MVPA bouts represent time spent in MVPA for a period of 10 minutes minimum, allowing for up to 2 minutes in lower intensity.

Objectively measured physical function. A physical performance test was used to assess physical function, namely the 20-meter timed walk test, which is a standard outcome measure in OA research (Osteoarthritis Research Society, 1996). A clearly marked start and finish point was laid out 20 metres apart inside the recruitment site. Participants were asked to walk this distance at their normal walking pace, starting one step behind the starting point. Upon confirmation from the researcher, participants started walking and the researcher set a stopwatch. The researcher followed the participant keeping a small distance at all times and set the stopwatch off when the participant's first heel completely crossed the finish point. Short distance self-paced tests have been found to be reliable and valid indicators of functional performance and functional limitations in lower limb OA (Fransen et al., 1997; Marks, 1994) and have predictive value for future extremity limitations in older adults (Cesari et al., 2005).

Height. Height was measured to the nearest centimeter using a stable stadiometer for mobile height measurement or a calibrated wall mounted stadiometer.

Weight, BMI, body composition. Weight, BMI and body composition were measured by a bioelectrical impedance scale (Tanita model MC-780MA). After confirming that they do not have a pace maker, participants were asked to remove any jewellery or metal accessories in contact with their skin and step on the scale barefoot. Age (self-reported), gender and height were entered into the Tanita Scale. Participants received a print copy of their outcomes (weight, BMI, estimated body fat etc., as printed by Tanita).

Self-reported measures

Participant characteristics. Demographic, disease-related and other general participant characteristics were assessed by single-item questions (open ended, yes/ no, multiple choice or Likert). These included participants' date of birth, gender, ethnicity, education level, marital status, work status, profession, financial strain, being a carer, receiving financial aid due to OA; also, family history of OA, history of joint injury, joint surgery, joint injections; use of medication for joint symptoms, other existing medical conditions and current medical treatment, and reported important stressful events during the past 12 months. In addition, maintenance of current PA engagement was assessed using a modified version of the stages of change for exercise question (Marcus et al., 1992). Responses ranged from 1 ("I currently don't engage in physical activities and I do not intend to start doing so") to 5 ("I engage in physical activities regularly. I have been doing so for more than six months"), the middle answer being 3 ("I engage in physical activities, but not regularly").

Knee symptoms and function. Patients' perception of their OA knee-related problems during the last seven days were assessed by the Knee Injury and Osteoarthritis Outcome Score (KOOS) (Roos and Lohmander, 2003). KOOS is a self-reported, 42-item instrument comprising five subscales that assess pain (9 items, e.g., amount of pain experienced when "walking on a flat surface"), function in daily living (17 items, e.g., degree of difficulty experienced due to the knee when "Getting in/out of car"), symptoms (7 items, e.g., "Does your knee catch or hang up when moving?"), function in sports/ recreation (5 items, e.g., degree of difficulty in the previous week when being active at a higher level such as "running") and knee-related quality of life (4 items, e.g., "How much are you troubled with lack of confidence in your knee?"). KOOS includes the WOMAC Osteoarthritis Index LK 3.0, which is a valid measure of evaluating knee OA in elderly individuals (Bellamy et al., 1988). Items are scored

on a 5-level Likert scale indicating “no” to “extreme” problems. Scores are calculated separately for each subscale by averaging and normalising the raw subscale item scores so that 100 represents no symptoms and 0 represents extreme symptoms. KOOS has good construct validity (Collins et al., 2011) and high test-retest reliability, that is, 0.60-0.97 for the four subscales in knee OA patients (Alviar et al., 2011).

Hip symptoms and function. Patients’ perceptions of their OA hip-related problems are assessed by the Hip Disability and Osteoarthritis Outcome Score (HOOS) (Klassbo et al., 2003). The scale is used to assess current symptoms, as well as short and long term changes. Similar to KOOS, HOOS is a self-reported, 40-item scale and comprises five subscales: pain (10 items, e.g., amount of pain experienced when “walking on flat surface”), function in daily living (17 items, e.g., degree of difficulty experienced due to the hip when “taking off sockes/stockings”), symptoms (5 items, e.g., “How severe is your hip joint stiffness after first wakening in the morning?”), function in sports/ recreation (4 items, e.g., degree of difficulty in the previous week when being active at a higher level such as “running”) and hip-related quality of life (4 items, e.g., “How often are you aware of your hip problem?”). Scoring is the same as with the KOOS. HOOS has high test-retest reproducibility, i.e., ICC > 0.78 (Klassbo et al., 2003) and is recommended for assessment for hip OA patients on non-surgical OA management (Thorborg et al., 2010).

Anxiety and depressive symptoms. The Hospital Anxiety and Depression Scale (HADS) (Zigmond and Snaith, 1983) was used to assess symptoms of anxiety and depression during the last week. HADS consists of 14 items divided into anxiety symptoms sub-scale (7 items, e.g., “worrying thoughts go through my mind”) and depressive symptoms sub-scale (7 items, e.g., “I can laugh and see the funny side of things”). Items are rated on four-point Likert scales from 0 to 3 (with 0 representing no symptoms, and 3 representing severe symptoms).

Total score is calculated by averaging scores for each sub-scale separately. HADS has been found to be a valid and reliable instrument for detecting depression and anxiety in OA (Axford et al., 2010).

Quality of life. Perceived quality of life was assessed by the 26-item World Health Organisation Quality Of Life-BREF (WHO-QOL-BREF; The WHOQOL Group, 1998). Physical (7 items, e.g., “To what extent do you feel that physical pain prevents you from doing what you need to do?”), psychological (6 items, e.g., “how much do you enjoy life?”), social (3 items, e.g., “how satisfied are you with your personal relationships?”) and environmental (8 items, e.g., “how satisfied are you with your transport?”) domains of quality of life are assessed and the scores are calculated separately for the respective subscales. A normalised score is calculated for all domains, ranging from 4 to 20. WHO-QOL-BREF has shown good test-retest reliability, discriminant and content validity (Seattle Quality of Life Group, 2017). The WHO-QOL-BREF has shown acceptable reliability for all domains (Cronbach’s $\alpha = 0.76-0.84$) and moderate concurrent validity for the physical and psychological domain in lower limb OA patients (Ackerman et al., 2006).

Self-Efficacy for Physical Activity/reducing ST. PA self-efficacy referred to the confidence in one’s ability to engage in weekly physical activities for 150 minutes (in 5 x 30min bouts or other combination) in the face of common barriers like weather, boredom, pain, mood etc. ST self-efficacy referred to confidence in one’s ability to interrupt one’s sitting time every 30 minutes. Both constructs were measured with modified versions of the Barriers-to-Exercise Efficacy Scale (ESS) (McAuley, 1993), commonly used in the exercise literature to assess self-efficacy. Each scale consisted of 9 items describing barriers, with responses ranging from 1 (not confident at all/I wouldn’t do it) to 10 (very confident/ I would do it) and the score was

calculated by averaging all items. The ESS scale has showed good reliability and validity in older adults (Resnick and Jenkins, 2000).

Outcome expectations for PA. Expectations regarding the effects of being physically active on physical health, sense of self and social relationships, were assessed by the Multidimensional Outcome Expectations for Exercise Scale (MOEES) (Wójcicki et al., 2009), adapted for physical activity. The scale has 15 items and includes three subscales, in particular physical (6 items, e.g., “Physical activity will improve the functioning of my cardiovascular system”), self-evaluative (5 items, e.g., “physical activity will give me a sense of personal accomplishment”) and social (4 items, e.g., “physical activity will make me more at ease with people”). Responses ranged from strongly disagree to strongly agree on a 5-point Likert scale and a score was calculated separately for each subscale by averaging the relevant items. The scale has showed good reliability and structural validity in research on older adults with impaired physical function (Hall et al., 2012; McAuley et al., 2010).

Motivational regulation for PA/ reducing ST. Motivation for PA/reducing ST, from autonomous motivation (intrinsic, identified) to external regulation (introjected, external) and lack of motivation, was assessed by adapting the Behavioural Regulation for Exercise Scale- 2 (BREQ-2) (Markland and Tobin, 2004). The adapted versions phrased the instructions around the questions “I am physically active because...” and “I aim to reduce my sitting time because...”, instead of “I exercise because...” in the original version. The questionnaires consisted of 19 items comprising the 5 subscales along the behavioural regulation continuum: intrinsic (4 items, e.g., “Because it is fun”), identified (4 items, e.g., “Because I think it is important to make an effort to do this regularly”), introjected (3 items, e.g., “Because I feel like a failure if I am not doing this”), external (4 items, e.g., “Because my friends and family say I should”) and amotivation (4 items, e.g., “But I don’t see why I should”). Participants could skip

the ST questionnaire if it was not applicable to them (that is, they were not trying to break up their sedentary time). Responses ranged from 1 (strongly disagree) to 5 (strongly agree) and a total score was calculated for each subscale, for autonomous and external regulation by averaging the respective items. BREQ-2 has showed good fit with the theoretical model (Markland and Tobin, 2004) and has showed good internal consistency in previous research with individuals with arthritis (Yu et al., 2015a).

Autonomy support from PA/ST reduction from important others. Perceived autonomy support from the consultant for being more physically active and reducing ST was assessed by two adapted versions of the Health Care Climate Questionnaire- Short form (G. C. Williams, Grow, Freedman, Ryan, and Deci, 1996). First participants were asked to identify the person(s) who is most important in their efforts to be more physically active/reduce ST or indicate that there is no such person. The two scales followed for those who had identified an important other. Each scale consisted of six items (e.g., “My consultant encourages me to ask question about this to improve my health”) and responses ranged from 1 (“strongly disagree”) to 7 (“strongly agree”) on a Likert scale. An average score was calculated for each behaviour. The scale has showed good reliability when administered to arthritis patients (Yu et al., 2015).

Autonomy support for PA/ ST reduction from consultant(s). Perceived support from the consultant for being more physically active and reducing ST was assessed by two adapted versions of the Health Care Climate Questionnaire-Short form (Williams et al., 1996). The scale was developed to assess the perceived autonomy support versus controllingness provided by the health care professionals. The two adapted versions consisted of six items for PA and ST, separately (e.g., “My consultant encourages me to ask question about this to improve my health”). Responses ranged from 1 (“strongly disagree”) to 7 (“strongly agree”) on a Likert

scale and an average score was calculated for each behaviour. The scale has showed good reliability in arthritis patients (Yu et al., 2015).

Physical environment. Aspects of the built physical environment, specifically the neighbourhood in which one lives, in relation to PA were assessed by a modified version of Assessing Levels of Physical Activity Questionnaire (ALPHA) (Spittaels et al., 2009). ALPHA consists of 49 items assessing: types of neighbourhood residencies (3 items, e.g., how common are detached houses in your immediate neighbourhood?); local facilities distance (8 items, e.g., about how long would it take to get from your home to the nearest supermarket?); walking/cycling infrastructure (4 items, e.g., there are sidewalks in my neighbourhood); walking/cycling network (4 items, e.g., there are many road junctions in my neighbourhood); infrastructure maintenance (3 items, e.g., the play areas, playgrounds parks or other open spaces in my neighbourhood are well maintained); safety (6 items, e.g., walking is dangerous because of the traffic in my neighbourhood); pleasantness (4 items, e.g., there is litter or graffiti in the streets of my neighbourhood); home environment (6 items, e.g., do you have a garden, including a yard, allotment or city garden?); and workplace environment (10 items, only relevant to those working/ studying, e.g., at your work or place of study do you have showers and changing rooms?). Responses are on Likert scales and vary with regard to number of Likert points and wording. Subscale score calculation is done by summing item scores, with the exception of types of residencies for which the score is calculated by weighting items before summing. ALPHA subscales have showed good test-retest reliability and predictive validity in adults across Europe, although low internal consistency has been reported for certain subscales (Spittaels et al., 2009).

Sample size

Given the observational, cross-sectional design of the study, sample size calculations were based on the minimum sample needed to detect a medium effect size when using Pearson's correlation and multivariate regression analysis. For a medium effect size ($r=0.30$) to be detected with a .80 power and significance criterion $\alpha=.05$ in a product-moment correlation, a sample size of 85 is required (Cohen, 1992). In linear regression models, where the effect size R depends on the number of predictors and sample size, a model with 6 predictors requires 98 cases to have 0.8 power to detect a medium effect size ($R^2= 0.13$) (Field, 2016, p 390). Taking into account the time and resource limitations, the target sample size was therefore set at 85 minimum, with a sample of 98 considered as providing sufficient power for comprehensive multivariate models to be tested.

CHAPTER 5

LEVELS AND CORRELATES OF ACCELEROMETER-ASSESSED PHYSICAL ACTIVITY AND SEDENTARY TIME: IMPLICATIONS OF DIFFERENT CUT POINTS IN PHYSICAL ACTIVITY CLASSIFICATION FOR HEALTH AND WELL-BEING

Introduction

Hip and knee osteoarthritis (OA) have a negative impact on individuals' physical and mental health. Lower limb OA is a cause of pain, compromised physical function and among the higher ranked conditions (11th out of 291 conditions) contributing to world-wide disability (Cross et al., 2014). In comparison to the general population OA patients are also at higher cardiovascular disease risk (Hall et al., 2016) and a larger proportion among them experience anxiety and depressive symptoms (Rosemann et al., 2007; Stubbs et al., 2016). Negative psychological states such as depression are further related to worse pain experience (Bartley et al., 2017), physical function (Scopaz et al., 2009) and fear of movement (Gunn et al., 2017).

Being physically active is considered essential for the maintenance of physical function in hip and knee OA (NICE, 2014; Rausch Osthoff et al., 2018). An increase in MVPA has a protective effect against future functional decline and disability (Dunlop et al., 2011; Song et al., 2017; White et al., 2017) and similar effects have been reported for LPA after controlling for MVPA (Dunlop et al., 2014). Contrasting findings have been also reported, specifically being in the highest tertile of LPA and MVPA was associated with worse pain and physical function (difficulty with activities of daily living) than being in the lowest after adjusting for confounders, although the effect was clinically non-significant (Liu et al., 2016). Besides physical function, health-related quality of life was significantly better in arthritis patients who met the physical activity (PA) guidelines than those who did not, based on data from a large-scale population study in US (n=33,071) (Austin et al., 2012). Additionally, findings from a systematic review on the associations of therapeutic exercise with health-related quality of life revealed mild to moderate positive effects in OA patients (Tanaka et al., 2015).

MVPA is therefore the intensity with established links to health benefits, the most studied and consequently addressed in official guidelines. An important point that requires clarification

is whether total MVPA, i.e., accrued in any pattern during daily activities, is equally beneficial as bouted MVPA. The World Health Organisation (WHO, 2010) established 10-minute bouts of MVPA as the minimum targeted PA duration. Cross-sectional evidence from the 2003-2006 National Health and Nutrition Examination Survey (NHANES), a large population study in US, showed associations of both patterns with reduced cardiovascular disease risk (Loprinzi et al., 2013) and better health-related quality of life (Loprinzi and Davis, 2016). Longitudinal data suggests that bouted MVPA adds little benefit to the positive effect of total MVPA with regard to all-cause mortality (Saint-Maurice et al., 2018) and cardiovascular disease risk (UK; Jefferis et al., 2019). Whether bouted or total minutes of MVPA are more relevant to general and OA-specific health outcomes in OA is yet to be determined.

The concept that ST has an independent negative effect on health and should be targeted separately in health-promoting interventions is a more recently evidenced in research (Benatti and Ried-Larsen, 2015; Healy et al., 2011). Spending less time sedentary and breaking up ST are beneficial for cardio-metabolic health above and beyond the effect of MVPA (Brocklebank et al., 2015; Carson et al., 2014). Breaking up sitting time (sedentary breaks), namely interrupting prolonged periods spent in sitting or reclining positions by standing and/or ambulatory activities, has emerged as an outcome of interest and potential relevance to health outcomes. In individuals with or at risk of knee OA, ST is negatively associated with physical function, concurrently (Lee et al., 2015) and longitudinally after controlling for MVPA (Semanik et al., 2015).

The development and application of accelerometers in PA research has created unprecedented opportunities to accurately quantify and assess daily PA and ST in the real world, including parameters such as duration, frequency, intensity and patterns. Accelerometers enable the robust examination of PA and ST associations with outcomes of interest, e.g. health and well-being. Accelerometers overcome the methodological limitations inherent in self-reported PA

measures, such as overestimation of PA (Prince et al., 2008; Shephard, 2003), underestimation of ST (Chastin et al., 2014a), and the complexity of energy expenditure assessment as a PA proxy (Hills et al., 2014).

Despite the advancements, a number of methodological considerations are inherent to the employment of accelerometry in PA research. To begin with, there is variability in the devices used and even within the same manufacturer, newer models differ from older ones. GT3X+ is a tri-axial accelerometer, the newest of a series of models produced by ActiGraph (ActiGraph, Pensacola, FL, U.S.A.), commonly used in more contemporary PA research. The development of triaxial accelerometers enables counts per minute (cpm) to be calculated based on the acceleration on three axis related to bodily motion- vertical, horizontal and perpendicular. Although the vertical axis of GT3X+ is comparable to the VA from older ActiGraph models like GT1M (Sasaki, John, and Freedson, 2011), research suggests that the three axis vector magnitude provides a more accurate estimate of PA intensity and energy expenditure (Santos-Lozano et al., 2013; Zisko et al., 2015). However, PA assessment based on vertical axis counts is not directly comparable to assessment based on vector magnitude. A recent systematic review identified 11 methodological issues with regard to GT3X data collection and analysis, for which there is no standardised approach within the research community (Migueles et al., 2017). These include device placement (locus), sampling frequency, epoch length, definition of non-wear time, definition of valid day/ week and classification of ST and PA intensity and classification of ST and PA intensity and need to be taken into account to ensure validity and comparability of research findings.

The decision on PA classification cut points for the cpm, which characterise the PA intensity (light, moderate, vigorous) and ST, is critical as it might have direct implications for health outcomes. Cut points derive from validation studies in age- or condition-specific

populations. Migueles et al. (2017) identified 78 validation studies, age-specific, for the GT3X accelerometers alone. There is great variability in PA classification depending on the cut points applied (Watson et al., 2014). For example, using eight different MVPA cut points validated in samples from the general population on a sample of 114 active community-dwelling older women yielded estimates ranging from four to 80 minutes of daily MVPA (Gorman et al., 2014).

An important source of accelerometer data in lower limb OA is the Osteoarthritis Initiative, a large-scale, multicentre, prospective study investigating US adults with or at risk of OA, which used the GT1M ActiGraph accelerometers (Fawaz-Estrup, 2004). OA Initiative-related publications have mostly applied Troiano et al. (2008) cut points, for example (Dunlop et al., 2011; Pellegrini et al., 2016). Troiano's MVPA cut points (>2019 cpm) are the weighted average from four validation studies on young healthy adults using uniaxial accelerometers, whereas the ST- LPA cut point is assumed rather than validated (Troiano et al., 2008). However, these cut points might not be the most appropriate for OA populations as they have been validated on a sample with different ages and physical abilities. A number of physiological changes take place with ageing, such as decline in the metabolic function and gait speed (Schrack et al., 2012) and PA patterns (Murphy, 2009), while the prevalence of chronic health conditions is increased. Cut points validated with older populations are suggested as more appropriate to use with relevant population sub-groups, such as OA (Hall et al., 2009; Watson et al., 2014).

Few validation studies exist that have been conducted in samples of older adults using triaxial accelerometers (Santos-Lozano et al., 2013; Sasaki et al., 2011). Santos-Lozano et al. (2013) used a validation protocol for MPA and VPA broader than the inclusion of treadmill-only conditions, in particular 4 treadmill conditions, a resting condition and repeated sit and stands, in two healthy adults age groups [middle aged (40-55 years) and older adults (65-80 years)]. They specified 3208 cpm and 2751 cpm as the vector magnitude cut points for each group respectively

as corresponding to 3 Metabolic Equivalent Tasks (METs). The age range in the older adults group is more relevant to OA populations, although these cut points have not been validated in OA specifically. For ST classification, Aguilar-Farias et al. (2013) identified vector magnitude <200 cpm as the ST cut point in free living conditions in a sample of older adults ≥ 65 years, corresponding to 1-1.5 METs.

Study aims

The aim of the present study was primarily to address the methodological issue outlined above regarding the use of age-relevant cut points for PA intensity/ ST classification in hip and knee OA when using the new generations of Actigraph® accelerometers; secondarily, to examine the relevance of MVPA way of accumulation, namely bouts or total, to health and well-being indicators in this population.

Specific objectives were:

1. To assess and compare (a) physical activity levels (light, moderate, vigorous, moderate-to-vigorous) and (b) the proportion of people meeting the official MVPA guidelines of 150 minutes of MVPA per week using Troiano's vs Santos-Lozano's older adults cut points.
2. To assess and compare ST using (a) Troiano's (<100 vertical axis cpm) and (b) Aguilar-Farias's (<200 vector magnitude cpm).
3. To examine the implications of using total vs bouts MVPA time for its associations with health and well-being outcomes relevant to people living with OA, namely physical function, assessed by a performance test and self-reported (OA-relevant); OA pain; physical and psychological quality of life; anxiety and depressive symptoms.

Methods

Study reporting is informed by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement (Vandenbroucke et al., 2007; von Elm et al. 2007). STROBE checklist can be found in Appendix 5.1.

Research design and setting

The study received ethical approval from the West Midlands Research Ethics Committee and Health Research Authority (16/WM/0371) and was adopted by the National Institute for Health Research Portfolio (Central Portfolio Management System ID 31488) (Appendix 4.1 for the letters of approval). This was a multicentre, cross-sectional, observational study. The study setting and procedures, rationale for sample size and consideration of sources of bias are presented in detail in Chapter 4. In sum, participants were knee and/ or hip OA patients, recruited from Secondary Care and community settings in West Midlands, East Midlands and South UK between February 2017 and February 2018 (Figure 5.1 for a detailed participant recruitment flow chart). Reasons given for non-participation by eligible participants during face-to-face recruitment included lack of interest or time. Participants who consented to take part paid one visit to the respective site. During the visit, which lasted approximately 1.5 hours, participants filled in a set of questionnaires, had their BMI and gait speed measured and took home a GT3X+ accelerometer to wear on their hip for one week during waking hours, which they then posted back to the research team.

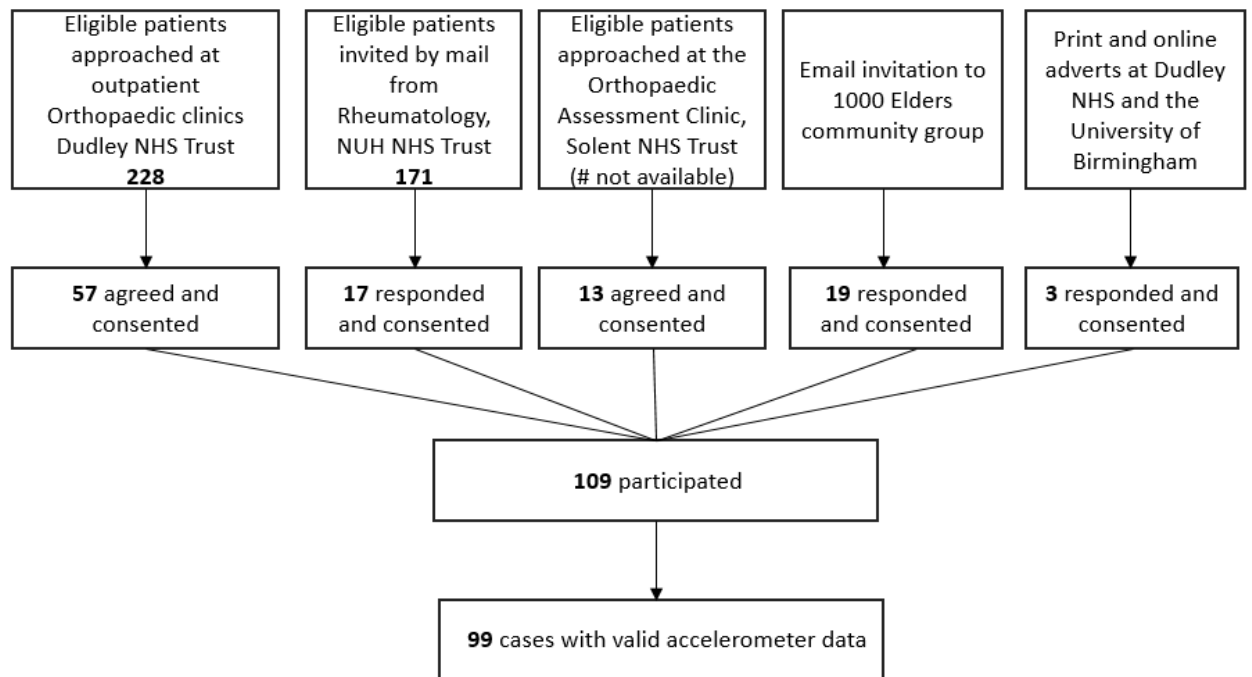


Figure 5.1 Participant Recruitment Flow Diagram

Participants

Adults 40 years of age or older with a physician-made diagnosis of hip or knee OA, who could ambulate independently or with the use of a walking stick, and who did not have other arthritic conditions were eligible to participate (detailed inclusion and exclusion criteria can be found in Chapter 4).

Measures

Objectively measured physical activity and sedentary time

Physical Activity and Sedentary time. GT3X+ ActiGraph® and its newest models wGT3X and wGT3X-BT triaxial activity monitors were used to assess PA and ST variables. Cpm were sampled at 30Hz frequency and processed in 60-second epochs.

Objectively measured physical function and body mass index

20-metre Timed Walk Test. The 20-metre timed walk test assesses gait speed and physical function. Participants were asked to walk at their normal pace along a 20-metre marked area. A stopwatch was used to count the time (seconds) required from start to finish. Short distance, self-paced timed tests have showed good reliability and validity in knee OA (Marks, 1994).

Body Mass Index. Height was measured by a stadiometer and the results were imputed in a Tanita bio-electrical impedance analysis scale (Tanita, model MC-780MA P) which calculated BMI.

Self-reported measures

Demographic characteristics. Age, gender, education level, marital status, work status and financial strain were assessed by single-item questions with standard pre-defined responses, except for age.

Other clinically relevant factors. Family history of OA, knee/ hip injury, injections and surgery history were assessed by single-item questions with binomial responses. OA medication/ supplements and comorbidities were assessed by open-ended questions.

Joint pain and activities of daily living. Knee Injury and Osteoarthritis Outcome Score (KOOS; Roos and Lohmander, 2003) and Hip Disability and Osteoarthritis Outcome Score (HOOS; Klassbo et al., 2003) assess a wide range of perceived knee and hip problems. The 9-item Pain and the 17-item Activities of Daily Living (ADL) subscales were used to assess pain and physical function in daily living activities. Responses range from “none” to “extreme” on a 5-point scale. Normalised scores are used, 0 indicated extreme symptoms and 100 indicating no

symptoms. These are validated instruments with high test-retest reliability: 0.80- 0.97 for knee OA (Collins et al., 2011) and > 0.78 for hip OA (Klassbo et al., 2003). Cronbach's α for this study was 0.89- 0.98 for the subscales used. A joint score, i.e., hip or knee, was created for pain and ADL separately to allow for whole sample use in the analysis.

Physical and psychological quality of Life. The World Health Organisation Quality Of Life-BREF (WHO-QOL-BREF; The WHOQOL Group, 1998) assesses perceived quality of life in four domains. The 7-item Physical and 6-item Psychological subscales, which assess the respective aspects in physical and mental health, were used. Responses range from 1 to 5 and transformed scores between 4 and 20, higher values indicating better quality of life. WHO-QOL-BREF has shown good test-retest reliability, discriminant and content validity (Seattle Quality of Life Group, 2017).

Anxiety and depressive symptoms. The Hospital Anxiety and Depression Scale (HADS; Zigmond et al., 1983) assessed levels of the relevant experienced symptoms. The two 7-item subscales have responses ranging from 0-3. Scores are calculated by summing each item score, ranging from 0 to 21, higher values indicating more severe symptoms. HADS is a valid instrument for assessing depression and anxiety with Cronbach α above 0.80 commonly reported (Bjelland et al., 2002).

Data analysis

Data processing

Objectively measured PA and ST. Epochs were screened to distinguish wear and non-wear time, namely periods of no or little activity according to a pre-defined threshold. The Choi et al. (2011) algorithm was used for non-wear time definition: 90 minutes of consecutive zero cpm with two minutes allowance for non-zero counts plus a 30-minute window of non-zero

counts before and after the non-zero counts. Choi algorithm has been proposed as an improvement of the Troiano et al. (2008) algorithm (Choi et al., 2011). For data to be considered valid, a 10-hour wear period per day for a minimum of four days including one day of the weekend, had to be met. This combination of valid days/ weeks is considered optimal to provide sufficient information on a person's waking times PA and weekly schedule while retaining the sample size, which is reduced when minimum wear-days are increased (Kozey-Keadle et al., 2017; Migueles et al., 2017).

Data were processed twice, firstly using cpm on one axis (vector magnitude) and secondly using cpm on the three axes (vector magnitude). For MPA and VPA classification, the following cut points were applied: (a) Troiano's 2020-5998 cpm for MPA and 5999 cpm for VPA on vertical axis counts (Troiano et al., 2008); (b) Santos-Lozano's 2751-9358 cpm for MPA and 9359 for VPA on vector magnitude counts (Santos-Lozano et al., 2013). MVPA is the sum of MPA and VPA. Because VPA represented a very small proportion of daily MVPA, it was not examined separately in subsequent analysis. For ST classification the cut points applied were: <100 cpm on vertical axis (Troiano et al., 2008) and <200 cpm on vector magnitude (Aguilar-Farias et al., 2013). Cpm that fell between ST and MVPA were defined as light PA (LPA). Bouted MVPA represents MVPA bouts of minimum 10 minutes allowing for up to 2 minutes with cpm below the threshold. Additionally, minutes per day, minutes per week, hours per day/ week (ST only) and proportion of total wear time (MVPA only) were calculated. A binomial variable, meeting MVPA guidelines or not, was computed for each set of cut points.

Missing data and scale calculation. For KOOS/ HOOS (KOOS User Guide, 2012) and WHOQOL-BREF (WHOQOL Group, 1998) specific instructions are in place for handling missing data allowing up to 50% of missing subscale items for KOOS/HOOS and 14-20% (which corresponds to one missing item per subscale) for WHOQOL-BREF. In line with the latter, all

other scales were calculated by allowing for one missing item per subscale, namely allowing for 11-20% missing data across scales.

Statistical analysis

PA variables (LPA, ST, total and bouted MVPA) were included in the analysis as continuous (daily average in minutes/ hours; aims 1a, 2) or binomial variable (meeting or not MVPA guidelines; aim 1b). In the bivariate correlations tested for Aim 3, total/ bouted MVPA was defined as percentage of total wear time, to account for wear-time as a confounder, and outcomes of interest were physical function, BMI, joint activities of daily living, joint pain, physical and psychological QoL, anxiety and depressive symptoms, all continuous variables.

Statistical analysis was performed using SPSS 24 statistics software and on an online calculator of the Steiger's z-statistic (Lee and Preacher, September 2013). All variables were examined for normality of distributions graphically and by skewness and kurtosis values. They were considered normally distributed when there was no obvious decline from normal curve and the quotient of statistic value/standard error was <1.96 (Field, 2018). Descriptive data are reported, including mean, standard deviation, minimum and maximum values for the continuous variables.

Objectives 1a and 2. Based on the distribution of the differences in adjusted daily MVPA, LPA and ST, paired sample t-tests and Wilcoxon signed ranks test were used for normally and not normally distributed differences respectively, to compare PA and ST between vertical axis and vector magnitude cut points.

Objective 1b. Fisher's exact test was used to test the differences in the proportion of participants meeting the MVPA guidelines when Troiano's vs Santos-Lozano's cut points were applied.

Objective 3. (a) Chi-square test was used to test for differences in participants' meeting guidelines when Troiano's and Santos-Lozano's cut points were used. (b) The relationships of total and bouted MVPA, as proportions of total wear-time, with OA-pain, OA- physical function, quality of life, anxiety and depressive symptoms were tested with Pearson's product moment correlation coefficient, for both cut points. 95% confidence intervals, bias corrected and accelerated, were also calculated and considered when normality assumptions were violated. For the bouted MVPA correlations, three extreme outliers were removed from the analysis. Steiger's Z test (Steiger, 1980) was run to compare the bivariate correlations (r coefficients) for Troiano-Santos Lozano bouted PA and Troiano-Santos Lozano total PA pairs.

Results

Participants' characteristics

One hundred and nine individuals with hip and knee OA took part in the study. 69.70% were recruited from secondary health-care sites. Mean age was 63.79 years (± 10.58), mean BMI was 29.68 (± 4.91); 63.34% were women, 60.58% married, 52.34% retired; 29.52% reported education to University level and 24.62% no higher education. No financial strain was reported by 60.03%. With regard to OA and health-related variables: 68.8% reported taking medication or food supplement (9.2%); 45% reported having OA family history and 38.56% injury, 52.28% having injections and 44.80% some invasive surgical procedure for treatment; 55% reported one or more comorbidities. Mean scores of the outcome measures joint pain, joint ADL, physical QoL, psychological QoL, anxiety and depressive symptoms, physical function (performance test) are presented in Table 5.1.

Table 5.1. Descriptive statistics for the study outcome measures

	Mean \pm SD	Range (scale range)	Normative range
BMI (kg/ m ²)	29.68 \pm 4.91	20.70-43.40	18.5-24.9
Women	29.08 \pm 4.71		
Men	30.73 \pm 5.15		
Physical function (20m timed walk test; sec)	18.43 \pm 3.92	11.23 - 29.05	15.38-19.28 ₁
Joint ADL (KOOS/HOOS ADL)	59.88 \pm 21.34	15.00 – 100 (0-100)	82.3-90.3(men) 78.8-83.1 (women) ₂
Joint pain (KOOS/HOOS pain)	63.46 \pm 21.53	13.24 – 100 (0-100)	84.0-91.4 (men) 73.1–84.1 (women) ₂
Quality of life-physical (WHOQOL-BREF)	13.60 \pm 3.07	7.43 - 18.86 (4-20)	18.38 ₃
Quality of life-psychological (WHOQOL-BREF)	14.91 \pm 2.44	8.67 - 20.00 (4-20)	17.65 ₃

Anxiety (HADS)	6.84 ± 4.07	0 – 17 (0-21)	0-8 ⁴
Depressive symptom (HADS)	4.87 ± 3.39	0 – 14 (0-21)	0-8 ⁴

BMI=body mass index; ADL= difficulties with activities of daily living; KOOS= knee injury and osteoarthritis outcome score; HOOS= hip disability and osteoarthritis outcome score; WHOQOL-BREF=World Health Organisation Quality Of Life-BREF; higher scores for physical function anxiety and depressive symptoms indicate worse outcomes; higher scores for joint ADL, pain, physical QoL and psychological QoL indicate favourable outcomes. Normative scale scores are reported. However, these do not constitute cut-points indicating clinical conditions with the exception of HADS scores.

¹Range reported for mild to moderate lower limb OA population (Motyl et al., 2013); ²normative values from a population-based cohort for ages 55-74 (Paradowski et al., 2006); ³normative scores reported from a population-based cohort for ages 60-69 (Hawthorne et al., 2006); ⁴a score of above 8 is considered as a cut-off for identifying “possible cases” for anxiety disorders and depression (Bjelland et al., 2002)

Number of cases with missing data varied for different variables: ten for accelerometer data, nine for physical function, four for BMI, one for joint activities of daily living, one for physical QoL, two for psychological QoL, two for anxiety and depressive symptoms.

Physical activity and sedentary time assessment

Three accelerometers were not returned, and one case had corrupted data that could not be processed. After applying the wear-time criteria, six cases were flagged as invalid. Thus, data from 99 accelerometers were further analysed. On average, participants wore the accelerometers for 6.46 (SD=0.92) days. Descriptive statistics of PA levels and ST for the two sets of cut points are presented in Table 5.2. Based on Troiano's counts, participants spent on average approximately 12 hours per day in ST, 85 minutes in LPA and 39 minutes in MVPA. Based on Santos-Lozano/ Aguilar-Farias's counts, participants spent on average 11 hours per day in ST, 120 minutes in LPA and 76 minutes in MVPA. Time spent in bouts MVPA was approximately 10 and 7 minutes for Santos-Lozanos and Troianos cut points respectively with less than one bout daily average (0.66 and 0.47 bouts per day respectively). Average minutes per day spent in each PA intensity/ MVPA pattern is the unit used in subsequent analysis, rather than total minutes or bout frequency for example. This allows for a more comprehensive understanding and comparison among the different intensities, total wear-times and also PA patterns reported in other studies (for example, Song et al. 2010).

PA level and ST comparisons between the two sets of cut points (Aims 1a and 2)

Paired samples t-tests revealed significant differences in LPA and ST when different cut points were applied. LPA was significantly lower when assessed by Troiano's (M=85.19, SE=2.90) in comparison with Santos-Lozano's cut points (M=121.07, SE= 3.9), $t(97)=16.94$, $p<.001$. Daily ST was significantly higher when assessed by Troiano's (M=727.48, SE=7.27), in comparison to Aguilar-Farias's cut points (M=654.61, SE=7.49), $t(96)=-27.73$, $p<.001$. A

Wilcoxon signed ranks test showed that MVPA was significantly lower when assessed by Troiano's (Mdn=34.73) in comparison to Santos-Lozano's (Mdn= 72.99) cut points, $z=-8.60$, $p<.001$.

Meeting MVPA guidelines (Aim 1b)

The proportion of participants who met 150 minutes of MVPA per week varied greatly between MVPA patterns and as a function of the cut points used. The MVPA pattern by cut point combination is presented in a contingency table (Table 5.3). The proportion of participants who met the guidelines was significantly different between the two cut points both for Total MVPA (Fisher's Exact Test $p=.032$) and for bouted MVPA (Fisher's exact test $p<.001$).

MVPA pattern correlations with health and well-being outcomes and comparison of correlation coefficients between cut points (Aim 3)

Total and bouted MVPA correlations with health and well-being indicators for each of the cut points and the Steiger's z-test for each pair of correlations are presented in Table 5.4.

Total MVPA

Pearson's r and 95% CIs showed a significant, moderate correlation between total MVPA and some of the physical health outcomes, i.e., physical function (performance test), BMI for both sets of cut points; also, with physical QoL for Troiano's counts only. Higher MVPA levels were related to better physical function, lower BMI and better physical QoL. Joint pain and difficulties in daily living were not correlated with total MVPA. With regard to psychological variables, for Santos-Lozano's counts only and based on the 95% CIs, psychological QoL and depressive symptoms presented a small to moderate correlation with MVPA. For higher levels of MVPA, psychological QoL tended to be lower and depressive symptoms higher. Steiger's z test revealed significant differences between the cut points in some of the physical health

Table 5.2. Descriptive statistics for physical activity levels and sedentary time

	Daily Mean \pm SD	
	Santos-Lozano/ Aguilar-Farias	Troiano
Light PA (min)	121.07 \pm 38.37	85.19 \pm 29.39
Moderate PA (min)	73.82 \pm 31.86	36.48 \pm 20.34
Vigorous PA (min)	2.20 \pm 1.20	2.30 \pm 1.93
Moderate-to-Vigorous PA, total (min)	76.03 \pm 32.55	38.78 \pm 21.37
Moderate-to-Vigorous PA, bouted (min)	9.46 \pm 14.39	6.97 \pm 12.24
Moderate-to-Vigorous PA, frequency of bouts	0.66 \pm 0.93	0.47 \pm 0.77
Sedentary time (min)	654.61 \pm 73.55	727.48 \pm 70.40

Table 5.3. Proportion of participants meeting the 150 min/week MVPA recommendations

MVPA guidelines met?	Bouted MVPA		Total MVPA	
	Santos-Lozano	Troiano	Santos-Lozano	Troiano
Yes	13.3%	10.2%	98%	81.6%
No	86.7%	89.8%	2%	18.4%

Table 5.4. Bouted and total MVPA correlations with health and well-being outcomes and comparisons of correlation coefficients between cut points

	MVPA (% of wear time)					
	<i>r</i> [95% CI BCa]					
	Santos- Lozano bouted	Troiano bouted	Steiger's z-value	Santos- Lozano Total	Troiano Total	Steiger's z-value
Physical function (walk test)	-.31** [-0.44,-0.17]	-.34*** [-0.47,-0.22]	.74	-.33** [-0.48, -0.15]	-.21* [-0.38, -0.03]	1.46
BMI	-.12 [-0.26, 0.04]	-.11 [-0.26, 0.02]	-.24	-.22* [-0.38, -0.04]	-.23* [-0.39, -0.04]	-0.16
Joint ADL	.31** [0.47, 0.14]	.32*** [0.47, 0.15]	-.25	.02 [0.22, -0.17]	.18 [0.36,-0.00]	2.48*
Joint pain	.29** [0.47, 0.10]	.29** [0.43, 0.10]	0	.04 [0.24, -0.15]	.14 [0.33, -0.05]	1.55
QoL physical	.28** [0.07, 0.47]	.29** [0.12, 0.44]	-.25	.00 [-0.22, 0.25]	.21* [0.02, 0.40]	-3.20**
QoL psychological	.07 [-0.09, 0.21]	.02 [-0.16, 0.18]	1.19	-.17 [-0.34, -0.02]	-.03 [-0.22, 0.15]	2.17*
Anxiety	-.18 [-0.35,-0.00]	-.14 [-0.29, 0.04]	-.09	.20 [-0.00, 0.37]	.06 [-0.14, 0.23]	2.13*

Depressive symptoms	-.27** [-0.40, -0.12]	-.26* [-0.38, -0.11]	-.25	.18 [0.02, 0.35]	.00 [-0.19, 0.21]	2.78**
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CI BCa= Confidence Intervals Bias corrected and accelerated; ADL= activities of daily living;

QoL= Quality of Life; *p<.05, **p<.01, ***p<.001

variables, namely joint ADL and physical QoL, and the three psychological variables. For these variables, Troiano's MVPA correlations indicated better physical and mental health outcomes than Santos-Lozano's: trend or significant associations with better ADL and physical QoL for Troiano versus null associations for Santos-Lozano; also, null association with anxiety, depression and psychological QoL for Troiano versus trend or significant associations with worse outcomes for Santos-Lozano.

Bouted MVPA

Average daily time spent in bouts MVPA was 6.97 (SD= 12.24) minutes and 9.46 (SD=14.39) minutes based on Troiano's and Santos-Lozano's counts respectively. For both sets of cut points, Pearson's r and 95% CIs revealed significant moderate correlations of bouts MVPA with most of the physical health variables (physical function, joint pain, joint ADL and physical QoL) but not with BMI. More time spent in bouts MVPA was related to better physical function, less joint pain, less difficulties in activities of daily living and better perceived physical QoL. Bouts MVPA was also correlated with depressive symptoms, that is, more time spent in bouts MVPA was related to lower levels of depressive symptoms for both sets of cut points. For Santos-Lozano's counts and based on 95% CIs only, anxiety presented a small to moderate correlation with bouts MVPA. That is, for higher levels of MVPA, lower levels of anxiety were reported. Steiger's z test revealed there were no significant differences in correlation coefficients between the two cut points.

Discussion

This study examined and compared accelerometer-assessed PA levels and ST in a sample of individuals with hip or knee OA from secondary care and community settings, based on two sets of cut points for PA/ ST classification, namely Troiano et al. (2008) and Santos-Lozano et

al. (2013). It further examined total and bouts MVPA associations with health and well-being indicators and the implications of using different cut points with regard to these observed associations. Applying a more age-relevant set of cut points resulted in more time being classified as MVPA and LPA, less as sedentary and a higher proportion of participants meeting the MVPA guidelines. Interestingly, these differences did not affect the relationships of bouts MVPA with the targeted indicators of health and well-being, although significant differences were found when total MVPA relationships were examined.

Sample characterisation

Before proceeding with a further discussion of the findings, it is important to have a comparative understanding of key characteristics of the study sample. Comparisons were made on the basis of Troiano's cut points, which are commonly used in the literature. Participants were engaging in more MVPA compared to existing studies in OA although there were variations for MVPA patterns and gender. For example, in a national sample from US, only 18.7% of adults with OA had at least 150 minutes of total MVPA based on Troiano's cut points (Liu et al., 2015). In a subsample of participants in the Osteoarthritis Initiative, engagement in total MVPA was on average 20.7 minutes for men and 12.3 for women, whereas the respective values for this sample were 42.00 for and 36.90 minutes (Dunlop et al., 2011). Similarly, Farr and colleagues in a sample of early knee OA patients reported total MVPA of 24.54 minutes per day based on a cut point of 2225 cpm on vertical axis- much less than the 36 minutes based on slightly more lenient cut points (2020cpm), but with an older mean age average in the present sample (Farr et al., 2008). With regard to bouts MVPA, Dunlop et al. (2011) reported 12.9% of men and 7.7% of women meeting guidelines, whereas in the present study the respective proportions were 8.3% and 11.3%. Proportions of 5-6% of lower limb OA patients meeting guidelines based on bouts MVPA have also been found in the MOST study (White et al.,

2013a). On the other hand, this sample spent more sedentary time than previously reported in arthritic conditions (Lee et al., 2015; Legge et al., 2017) and in the general population (Evenson et al., 2011) based on uniaxial accelerometer cpm. For example, Semanik et al. (2015) found that, among 1659 individuals from the Osteoarthritis Initiative, the average sedentary time was 9.8 hours, much less than the 12.12 hours in this present sample for similar amount of total wear time.

With regards to OA-related problems, participants presented with a great range of joint pain and difficulties with daily living, from non-existent to very high. In comparison with KOOS and HOOS scores reported in the literature, this sample can be characterised as experiencing moderate pain and difficulties. For example, a systematic review on populations with knee OA using KOOS as an outcome measure found mean scores for pain= 50.7 and for ADL=54.2 (N. J. Collins et al., 2011). Worse scores have been reported for hip and knee OA patients awaiting for arthroplasty (pain=34.4-39, ADL=34.9- 43.8) (Naylor et al., 2014) and for inactive individuals with knee OA (pain=37.1, ADL=32.2) (Sivachidambaram et al., 2014). Anxiety and depressive symptom scores (6.84 and 4.87) respectively were on average well below the score of 8 points for considering clinical cases (Bjelland et al., 2002; Zigmond and Snaith, 1983).

What can MVPA patterns tell us about health and well-being in lower limb OA?

Significant variation in time spent in MVPA, LPA and ST when different cut points/axis counts are used is a recurrent finding in the literature (Evenson et al. 2012; Migueles et al., 2017; Watson et al., 2014). However, the finding that this variation did not affect the relationships between bout MVPA and positive outcomes on health and well-being, but was relevant to most of the total MVPA correlations, is a novel one. Overall the findings suggest that a number of different behavioural patterns are classified together when total MVPA is calculated, whereas

bouted MVPA is a distinct and important pattern in hip and knee OA. Observed physical function had significant moderate-to-strong correlations across cut points and MVPA patterns, as has been previously reported for health-related outcomes (Jefferis et al., 2019; Loprinzi et al., 2013). However, only bouts MVPA was consistently associated with a positive health and well-being profile in this sample. This is not in line with existing literature from the general population (e.g., Loprinzi and Davis, 2016). We found that more time spent in bouts MVPA was related to less pain and difficulties in ADL, better physical QoL, lower levels of depressive symptoms and anxiety (trend), despite average MVPA time being low, that is approximately 7 and 10 minutes per day for Troiano's and Santos-Lozano's cut points respectively. It might be the case that individuals with less disabling OA and physical function/ mobility, are more likely to engage in bouts MVPA and experience less depression and anxiety. In explicating these findings, it might also be the case that those engaging in more bouts MVPA manage their OA symptoms better, have better physical function (Batsis et al., 2016; Dunlop et al. 2011) and therefore better quality of life and well-being (Tanaka et al., 2015) or that those with more reported depression and anxiety, experience greater OA-related disability and worse QoL (Bartley et al., 2017; Scopaz et al., 2009). These potential explanations are not mutually exclusive since there is a known interaction between physical and psychological variables (e.g., Bartley et al., 2017; Hunt et al., 2008).

On the other hand, in terms of the present findings, total MVPA calculated by three-axis and age-relevant cut points (Santos-Lozano et al., 2013) allowed for double the amount of total MVPA to be classified as MVPA in comparison to commonly used cut points (Troiano et al., 2008). Contrary to our expectations and existing literature (Song et al. 2017), total MVPA was uncorrelated with OA variables and was uncorrelated/ correlated with worse psychological variables. More time spent in moderate PAs sporadically during the day is reflected on physical

function and BMI. Based on Troiano's cut points, the additional 38 minutes of Santos-Lozano's MVPA would be classified as LPA. Song and colleagues recently found that individuals with knee OA who experienced more severe pain tended to spend less time in MVPA, but more time in LPA, using Troiano's cut points (Song et al., 2018). Also, the absence of correlation between musculoskeletal outcomes (lower limb muscle strength and physical function-performance test), and LPA levels have been reported from a population based study (Wu et al., 2017). These findings are suggestive that more time spend in this particular intensity level (high-LPA/ low MPA) might represent a slow-down in daily activities due to OA symptoms which is reflected in well-being indicators.

The limited amount of time spent in bouted MVPA daily is probably insufficient for weight management, hence the non-significant correlations with BMI in contrast to total MVPA. This might explain the discrepancy between current findings and those of cohort studies (Jefferis et al., 2019), who found no difference in CVD risk indicators between bouted and total MVPA when comparing participants who met 150 minutes of MVPA.

Implications for research and clinical practice

This study has important implications for future research and clinical practice. Firstly, selection of cut points might not be significant when bouted MVPA is examined but has implications for certain outcomes when sporadically accumulated MVPA is the focus in research. Therefore, characterisation of an OA population as sufficiently active or not based solely on total MVPA scores might not be a meaningful outcome when it comes to being considered automatically as an indicator of health and well-being outcomes. Secondly, setting 150 minutes of MVPA as a target in this population appears to be unrealistic regarding bouted and not necessarily beneficial for OA symptoms and well-being with regard to total MVPA (White et al., 2013a). Thirdly, bouted MPA, even in lower intensity (Santos-Lozano's cut points) could be an

appropriate target for PA promotion and PA prescription in lower limb OA patients. In contrast to strenuous PA, MPA can have a protective biochemical effect on the osteoarthritic joint (Castrogiovanni et al., 2019) and is linked to more positive affect neurophysiologically in the general population (Ekkekakis and Brand, 2018).

Strengths and limitations

The present study is a novel and critical approach in PA assessment in lower limb OA with important implications for future research. Certain limitations of the current research, however, should also be acknowledged. The study sample has certain characteristics that could be related to response bias and might not allow generalisation to lower limb OA, specifically the relatively high levels of MVPA and ST and low levels of anxiety and depressive symptoms. However, there is a good representation of disease severity, age and gender, which are known PA determinants. Bouted MVPA was not normally distributed since a significant proportion of participants had zero bouts, specifically 42% for Troiano's and 33% for Santos-Lozano's cut points. The use of confidence intervals is a robust alternative in cases of non-normality (Field, 2016). In addition the findings are in agreement with existing work on sedentary patients with knee OA reporting a significant sporadic PA-physical function association. Lastly, to avoid obscurity, only one bout duration was examined.

Conclusion

The application of an age-relevant set of cut points resulted in more time being classified as LPA and MVPA and less time as ST in comparison to commonly used set of cut points. However, the differences in MVPA estimates between the cut points did not yield significant differences in the strength of bouts/ total MVPA correlations with physical function and BMI and of bouts MVPA correlations with disease-related and well-being variables. The

findings indicate that first, PA/ ST levels of a population with OA on their own might not be an informative indicator with regard to health and well-being; secondly, bouted MVPA could be a behavioural pattern of particular importance for OA outcomes and well-being in this population. Future research on more representative OA samples and populations with other relevant conditions is needed to confirm the present findings.

CHAPTER 6

PSYCHOLOGICAL AND ENVIRONMENTAL PREDICTORS OF MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY, PHYSICAL FUNCTION AND QUALITY OF LIFE IN LOWER LIMB OSTEOARTHRITIS: ASSESSING A PATH MODEL FOR DIFFERENT PATTERNS OF PHYSICAL ACTIVITY ACCUMULATION

Osteoarthritis (OA) is a common joint disease that negatively impacts physical function (McDonough and Jette, 2010; Rydevik et al., 2010) and quality of life (QoL) (Farr et al., 2013a; Kawano et al., 2015). Physical activity (PA) has a positive impact on physical and mental health (Bouchard et al., 2012). In older adults more moderate and vigorous PA is related to reduced risk of disability (Paterson and Warburton, 2010). For example, a change in six months from meeting the guidelines of 150 min MVPA (self-reported) to not meeting them, was associated with decreased physical function- and vice versa (Morey et al., 2008). In individuals with lower limb OA specifically, the links between daily accruals of PA with indices of physical function are well supported, e.g. on data from the Osteoarthritis Initiative cohort study (Batsis et al., 2016; Dunlop et al., 2011; Song et al., 2017). In participants with radiographic knee OA, one-year change in self-reported overall PA showed a graded association with functional performance (20-meter walk test) (Dunlop et al., 2011). For inactive participants, namely those accumulating zero bouts of moderate-to-vigorous PA per week, with or at risk of OA, an increase in objective bout MVPA from baseline to two years had a graded inverse association with self-reported functional limitations (Song et al., 2017).

In the health context, quality of life (QoL) is relevant not only to physical health, but also mental and social well-being. When assessing health outcomes, it is important to take into account both physical and psychological aspects of QoL, as objective physical function is not always related to life satisfaction (Rejeski and Mihalko, 2001). Research involving older adults has shown that although PA is directly related to physical QoL, its relationship with psychological QoL can be indirect, via a relationship with psychological constructs such as PA self-efficacy (McAuley et al., 2011; Phillips et al., 2013). A positive graded association between objective bout MVPA and overall QoL has been reported based on cross-sectional data from

Osteoarthritis Initiative after controlling for demographic and health-related factors (Sun et al., 2014).

Multiple levels of factors, from individual to social and physical environmental, influence PA (Sallis and Owen, 2015). Among the most popular theoretical frameworks that examine individual-level, social psychological PA determinants is Social-Cognitive Theory (SCT) (Bandura, 2004). A key concept in SCT is self-efficacy (SE) which is defined as a person's belief he/she can successfully perform an action (Bandura, 1982). An extensive body of research has found SE to predict engagement in and changes in PA behaviour (Bandura, 2000b; McAlister et al., 2008; White et al., 2012), and also to play a role in understanding PA and well-being associations (Bandura, 2004; McAuley et al., 2011; Netz et al., 2005). A meta-analytic review of more than 15,000 participants with chronic pain, including OA, revealed a significant positive relationship between SE (for arthritis, pain, symptoms, function, exercise) and physical function (as measured by performance tests, accelerometers or self-reported scales) (Jackson et al., 2014). For the OA subsample of this meta-analysis (about 8%), SE had a moderate to strong effect on impairment, pain and distress, with effect sizes -0.40, -0.41 and -0.42, $p < .001$ respectively. Few studies have focused on PA SE in arthritis populations, specifically SE for overcoming barriers to being more physically active in contrast to participating in structured exercise (exercise SE) or managing arthritis symptoms (arthritis SE). Prospective studies confirm a positive association between PA SE/ change in PA SE and PA at follow up (Mielenz et al., 2013; Peeters et al., 2015). Over the course of 22 days, Zhaoyang and colleagues (2017) examined the effects of morning PA SE on same day objectively assessed MVPA in knee OA patients. Higher morning SE predicted more minutes of total daily MVPA (>760cpm) above and beyond the effects of demographic, health and psychosocial variables (e.g. affect, spouse's support) (Zhaoyang et al., 2017). SCT also acknowledges the role of

social-structural environment on behaviour: factors relevant to social interactions such as vicarious experiences and verbal persuasion have an influence on SE (Ashford et al., 2010), also social-structural factors are considered to partly mediate the SE-PA association (Bandura, 2004).

Physical environmental influences on the other hand are rarely accounted for in PA research along with psychosocial factors. The challenges related to controlling for the variability of the contexts where people move in and changing them are the most likely reasons. Defining a physical environment as the area within a radius from a point of reference like as one's home, can make PA-environmental associations detectable (Cleland et al., 2010). Proximity or accessibility of facilities, such as commercial, recreational and open spaces, is one of the most common and significant environmental characteristic positively associated with PA (Barnett et al., 2017; Duncan et al., 2005; Van Cauwenberg et al., 2011). Cross-sectional data from 11 countries worldwide demonstrated that existence of local facilities, like shops and street sidewalks, within 10-15 minute walking distance from one's home, was associated with higher chances of being physically active (Sallis et al. 2009). Similar findings are reported from a recent systematic review and meta-analysis of 100 studies in older adults (>65 years): neighbourhood walkability, street connectivity and access to facilities were significantly correlated with PA and walking in particular, whether self-reported or objectively assessed (Barnett et al, 2017). Limited research exists, however, on potential physical environmental influences on PA in people living with lower limb OA. Timmermans and colleagues (2016) for example, using objectively measured PA found that distance of health and shopping facilities had a stronger positive correlation with total PA and light PA for older adults with OA than those without (Timmermans et al., 2016) .

Keeping physically active is a challenge when experiencing joint pain and limitations as with knee and hip OA. The increase in the use of ecological approaches in PA research has long been documented (Trost et al., 2002) and multivariate PA determinants have been studied in various populations (Booth et al., 2000; Wilcox et al., 2003), but to the authors' knowledge not in OA.

Study aims

This study aimed to extend research on determinants and benefits of MVPA by testing a sequence of the above presented factors in an integrated model. In particular, we tested the implications of social psychological (PA SE) and physical environmental (facilities distance) factors for MVPA, physical function and QoL in hip and knee OA patients (conceptualised model presented in Figure 6.1). It was hypothesised that SE and facilities distance would be directly related to objectively measured MVPA (paths A1, A2; Figure 6.1). In turn MVPA would be directly correlated with physical function (B2); also, MVPA would have direct (B1, B3) and indirect (B2-C1, B2-C2) through physical function effects on physical and psychological QoL. Further, potential indirect effects of SE and facility distance on physical function (A-B2) and QoL (A-B1, A-B3, A-B2-C1, A-B2-C2) via the mediation of MVPA and physical function were also examined.

Given the differences in health and well-being correlations found for bouted and total MVPA in the previous chapter, the study further tested in an exploratory manner the applicability of the above model separately for each of the two MVPA patterns.

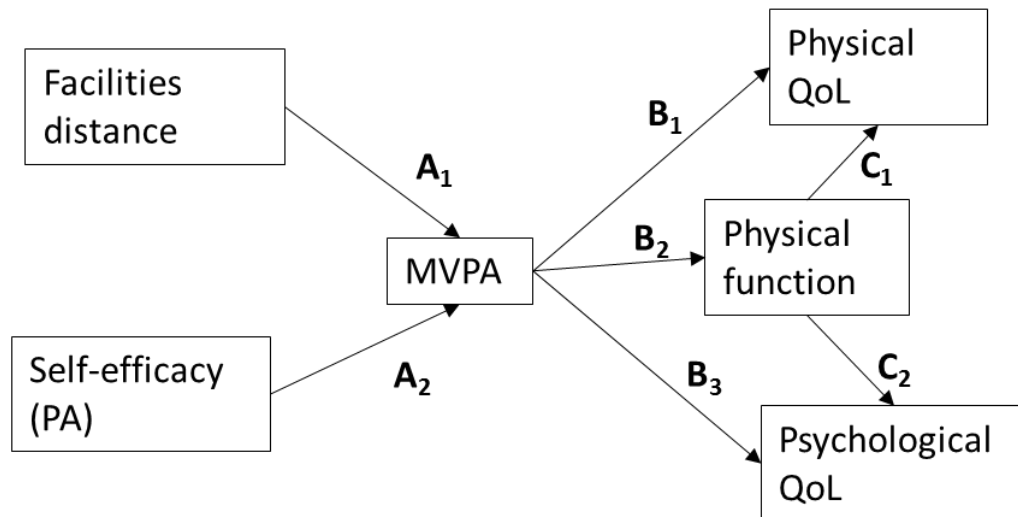


Figure 6.1 Hypothesised model of MVPA

A hypothesis of associations between self-efficacy for PA and facilities distance, daily MVPA, physical function, physical and psychological quality of life. PA= physical activity; MVPA= moderate-to-vigorous physical activity; QoL= quality of life

Methods

Study design, setting and procedures have been described in detail in Chapter 4. In brief, participants were adults above 40 years with hip or knee OA physician-made diagnosis, recruited from secondary health-care and community sites. If they had multiple OA sites, then the joint of primary complaint should not have been undergone/ be due to surgical treatment. After providing informed consent, participants completed a questionnaire pack and a physical function performance test. Participants took home and wore a GT3X accelerometer for 7 consecutive days during waking hours, which was then posted back to the research team.

Outcome Measures

Self-efficacy

Barriers-to-PA Self-efficacy (SE), that is confidence in one's ability to engage in weekly physical activities in the face of common barriers like weather, boredom, pain, mood etc., was measured with a modified version of Barriers-to-Exercise Efficacy Scale (McAuley and Mihalko, 1992). The modification consisted of a change in the question wording from "exercise three times per week" to "take part in physical activity (e.g. walking) five times per week for 30 minutes (or other frequency/ duration, but still about 150 min/ week in total)" to be in line with the study focus. The internal consistency of the present scale was the same as the one reported for the original scale, Cronbach's alpha 0.88 (McAuley and Mihalko, 1992). Further, in the present study, albeit non-significant, SE showed a trend for positive correlation with bouts MVPA, a strong, positive correlation with psychological quality of life and the respective path model showed good fit. For total MVPA there were no statistically significant results, thus providing support of the criterion validity of the scale used (Pedhazur and Pedhazur-Schmelkin, 1991).

Facilities distance

Distance to local facilities such as shops, services, transportation, leisure and recreational, was assessed using the eight-item subscale from ALPHA questionnaire that measures perceptions of environmental characteristics (Spittaels et al, 2010). A Cronbach's alpha of 0.86, test-retest reliability of 0.87 and moderate predictive validity have been reported (Spittaels et al., 2010).

Objectively measured physical activity

MVPA was assessed using the GT3X accelerometers. Bodily movement on 3-axis and per second was recorded. Minutes or bouts of minimum 10 minutes when intensity was above the moderate-to-vigorous cut-point (>2750 counts per min) were calculated and corresponded to total and bouted MVPA respectively.

Physical function

A physical performance test, namely 20-meter timed walk test, was used to assess physical function. Short distance self-paced tests have been found to be reliable and valid indicators of functional performance and functional limitations in lower limb OA (Marks, 1994; Fransen et al., 1997) and have predictive value for future extremity limitations in older adults (Cesari et al. 2005).

Physical and Psychological Quality of Life

Physical and psychological domains of quality of life were assessed by the relevant seven-item and six-item subscales of the World Health Organisation Quality Of Life-BREF (WHO-QOL-BREF; The WHOQOL Group, 1998). WHO-QOL-BREF has been found to have good test-retest reliability, discriminant and content validity (WHOQOL Group, 1998). In a severe lower limb OA population, physical and psychological domains had good psychometric properties (Ackerman et al., 2006)

Demographic and disease related characteristics.

A number of demographic, such as age, gender, marital status, ethnic background, education level, difficulty in paying monthly bills, and disease related variables, such as medication use for OA symptoms, treatment with injections, other important health conditions, were assessed by single item questions (yes/ no, Likert or open ended).

Statistical analyses

Statistical analysis was conducted with SPSS 24 and SPSS AMOS 24 software. Preliminary analysis included testing for normality of all study variables and their associations. Bivariate Pearson's correlation with bootstrapping (1000 samples) was used for the continuous variables, i.e. the test was considered significant when the 95% bias corrected confidence intervals (BC CIs) did not contain point 0. T-test was used to examine differences in MVPA for categorical variables. To test the hypothesised models, path analysis was employed. Path analysis is based on analysis of covariance structures and examines various models (or paths) than link a set of variables (Streiner, 2005), including mediated paths. This analytic approach has become popular in social sciences as it accounts for the complexity of real-life phenomena, where for example one variable can be both a predictor and an outcome. To test the proposed structural model, Maximum Likelihood estimation was applied (Streiner, 2005). First, data were screened for multivariate normality and outliers. This is an important step in this covariance structures analysis as multivariate normality is a strong assumption (Byrne, 2016). Multivariate kurtosis >7 and Mahalanobis distance from the centroid being significant at $p < .001$ are indicators of non-normality and substantially deviant cases respectively (Byrne, 2016).

To assess goodness-of-fit of the model, a series of statistics were examined: (i) Chi square statistic, χ^2 . A significant chi-square test indicates “badness” of model fit (Byrne, 2016). Chi-square is influenced by sample size, therefore a number of goodness-of-fit indices were additionally examined (Browne and Cudeck, 1992; Byrne, 2016; Norman and Streiner, 2000): (i) Comparative Fit Index (CFI), which compares data to a null model and also accounts for sample size; (ii) Tucker-Lewis Index (TLI). CFI and TLI values below .90 indicate that the model can improve substantially (Bentler and Bonett, 1980). Values of .95 or more have been reported to indicate excellent fit (Hu and Bentler, 1999), although these are dependent on

sample and model characteristics; (iii) Steigers Root Mean Square Error of Approximation (RMSEA). MacCallum et al. (1996) suggest that RMSEA values around .06 indicate a good fit, values up to .08 reasonable errors of approximation (Browne and Cudeck, 1992), .08 to .10 indicate mediocre fit and above .10 poor fit (MacCallum et al 1996). CIs are available for RMSEA, which reveal good model precision when narrow (Byrne, 2016, p.99). When sample size is small TLI and RMSEA tend to over-reject true models (Hu and Bentler 1999). (iv) Standardized Root Mean Square Residual (SRMR), which is an absolute measure of fit. SRMR close to .08 indicate a relatively good fit (Hu and Bentler, 1999). Overall, usefulness of the model should be based on more than one index, a balance between model plausibility and parsimony, experience and theory (Byrne, 2016; Marsh et al, 2004). Model misspecification was examined via the Modification Indices produced by Amos and parameters with values >10 were considered for change if they made “substantive” theoretical and empirical sense (Byrne 2016, p.103). Squared multiple correlations were used to estimate the proportion of variance of the assessed variables explained by the model. Bootstrap (bias corrected, 95% CIs, 1000 samples) was applied to examine significant indirect effects of the model variables.

Results

Participant characteristics

Eighty three participants had valid measures on all variables examined. Descriptive statistics for the continuous study variables (age, physical function, PA SE, facilities distance, QoL, MVPA) are presented in Table 6.1. The majority of the participants were women (67.5%), married or living with partner (68.6%), retired (55.4%), White British (78.3%) and reported no financial strain (60.2%). About 36% had a university education and 22% had no education beyond secondary school. Most of the participants had knee OA (72.3%), were recruited from

secondary care (68.7%), were using medication to manage their OA symptoms (57.9%), had had at least one joint injection (50.6%) and had at least one co-morbid condition (56.6%).

Bivariate correlations

The results of Pearson's correlations between the study variables are presented in Table 6.2. Total MVPA, bouted MVPA and timed walk test had skewness values greater than twice their standard errors, therefore bootstrapped 95% Bias corrected Confidence Intervals (95% BC CIs) are also reported. With regards to MVPA predictors, facilities distance had a moderate

Table 6.1. Descriptive statistics of the study variables (continuous)

	Mean \pm SD	Range
Age	64.07 \pm 10.36	42 - 84
Physical function (sec)	18.19 \pm 3.80	11.23 - 29.05
Self-efficacy for PA	5.42 \pm 1.84	1.11 - 9.00
Facilities distance	23.78 \pm 6.37	10 – 37
Physical quality of life	13.97 \pm 2.97	7.43 - 18.86
Psychological quality of life	15.16 \pm 2.38	8.67 - 20.00
Total MVPA (min/day)	74.53 \pm 30.52	20.62 - 158.26
Bouted MVPA (min/day)	9.19 \pm 13.91	0 - 79.20

PA=physical activity; MVPA=moderate-to-vigorous physical activity

Table 6.2. Internal reliability and bivariate correlations amongst variables in the hypothesised models.

	Cronbach's α	Total MVPA	Bouted MVPA	Self- efficacy	Facilities distance	Physical function	Qol physical
1.Total MVPA	—	—					
2.Bouted MVPA	—	.43*** [0.25, 0.59]	—				
3.Self-efficacy	0.88	.07 [-0.16, 0.30]	.12 [-0.08, 0.36]	—			
4.Facilities distance	0.81	-.35** [-0.50,- 0.20]	-.32** [-0.48,- 0.19]	.04 [-0.18, 0.25]	—		
5.Physical Function	—	-.27* [-.044, - 0.10]	-.36** [-0.48,- 0.24]	-.24* [-0.42, - 0.04]	.19 [-0.02, 0.38]	—	
6.QoL physical	0.84	.05 [-0.17, 0.26]	.31** [0.09, 0.54]	.23* [-0.03, 0.46]	-.31** [-0.50, - 0.10]	-.40*** [-0.59, - 0.18]	—
7.QoL psychological	0.82	-.10 [-0.27, 0.08]	.07 [-0.11, 0.25]	.40*** [0.18, 0.58]	-.13 [-0.32, 0.08]	-.23* [-0.48, 0.03]	.62*** [0.49, 0.74]

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; MVPA=moderate-to-vigorous physical activity; bouted= accumulated in 10-min bouts; QoL= quality of life

negative association with total and bouts MVPA. That is availability of facilities at a closer distance was related to more MVPA. Self-efficacy was positively but non-significantly correlated with both MVPA measures. Total MVPA had a significant small-to-moderate association with physical function, specifically more MVPA was related to better performance at the walk-test, but non-significant correlations with physical and psychological quality of life. Bouted MVPA had a significant moderate association with physical function and physical, but not psychological, quality of life, specifically more bouts MVPA was correlated with better performance at the walk-test and higher physical QoL. Physical function was significantly and positively correlated with both physical and psychological quality of life. PA SE, facilities distance, physical and psychological QoL scales demonstrated good internal reliability, with Cronbach's alpha (Cronbach, 1951) ranging from 0.81 to 0.88.

Known demographic and accelerometer-related correlates of MVPA were examined (age, gender and wear time). There was a significant negative association of age with total MVPA ($r=-.26$, $p=.02$, 95% BCa CI [-0.44, -0.07]), but not with bouts MVPA (95% BC CIs [-0.12, 0.28]). There were no significant gender differences in total ($p=.74$) or bouts ($p=.23$) MVPA. Also, no significant associations of wear time with total (95% BC CIs [-0.04, 0.60]) or bouts MVPA (95% BC CIs [-0.05, 0.35]) were observed.

Path analysis

Inspection of multivariate outliers identified one case farthest from the centroid at $p<.001$, which was removed from the analysis. Next, the fit of each of the hypothesised models to the data was examined.

Total MVPA. The hypothesised model showed poor fit to the data ($\chi^2(8)=63.33$, $p<.001$, CFI=.36, TLI=-.21, RMSEA=.29 (90% CIs [0.23, 0.36], PCLOSE=.00), SRMR=.18). A second

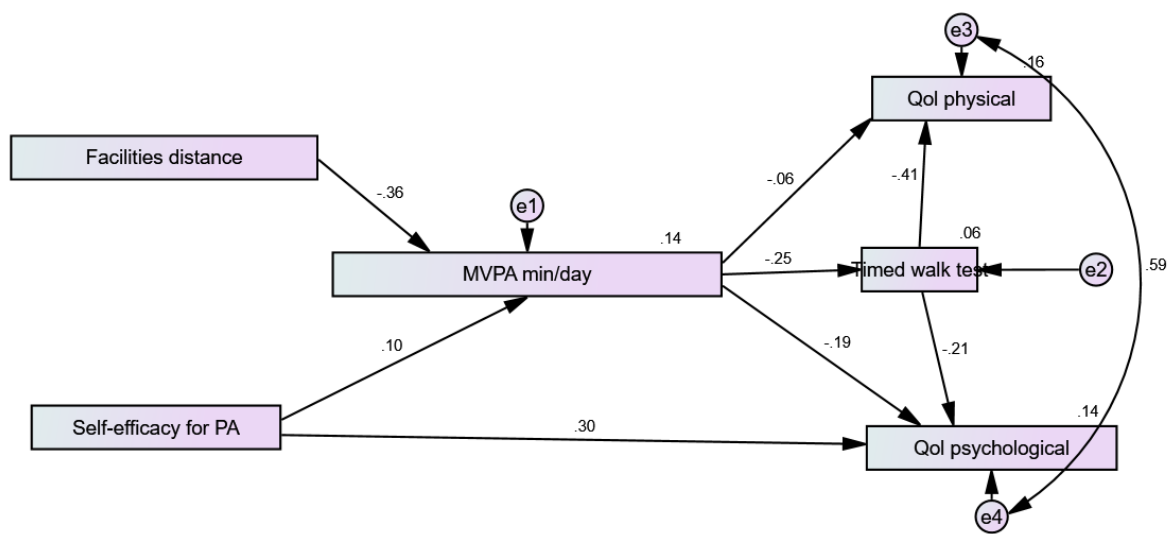


Figure 6.2 Modified path model for daily minutes of total MVPA (poor fit)

The hypothesised model for total MVPA, modified with two additional paths, one direct from self-efficacy for physical activity to psychological quality of life (QoL) and a covariance between the two QoL error terms. The model fit remained poor even after these modifications. The standardised path coefficients for each path are displayed on each path, but were not considered due to poor model fit. MVPA=moderate-to-vigorous physical activity; QoL= quality of life; e1- e4= errors terms associated with each observed variable, which are used in path models to represent random measurement error and error arising from specific variable characteristics (Byrne, 2016, p.10)

model was tested adding a direct path from age to MVPA. Model fit remained poor ($\chi^2(13)=70.33$, $p<.001$, CFI=.40, TLI=.02, RMSEA=.23 (90% CIs [0.18, 0.29], PCLOSE=.00), SRMR=.17). Modification indices (M.I.) large enough to improve model fit (Byrne, 2016) were then reviewed. Of the five M.I.s >10, two modifications, i.e. a direct path from psychological to physical QoL (M.I.=29.02) and the other way round (M.I.=24.23), were

rejected as they would result in an unidentified model. A path from SE to psychological QoL error term (M.I.=10.55) was rejected as not substantially meaningful. A direct path from SE to psychological QoL (M.I.=10.57) was added to the model, since an effect of SE on psychological QoL makes theoretical and empirical sense (Elavsky et al., 2005; McAuley et al, 2011). In a hip OA sample, Sunden et al (2013) tested a path from arthritis SE and physical function to physical and psychological QoL (SF-36) and also reported a significant effect of SE on psychological QoL. Also, a covariance between the two QoL error terms (M.I.=30.12) was added. With the additions of the latter two paths, model fit was improved, but was still poor ($\chi^2(6)=17.01$, $p=.01$, CFI=.87, TLI=.68, RMSEA=.15 (90% CIs [0.07, 0.24], PCLOSE=.03), SRMR=.18) (Figure 6.2). This unacceptable fit was observed even when adjusting for age ($\chi^2(11)=23.81$, $p=.01$, CFI=.86, TLI=.74, RMSEA=.12 (90% CIs: .05- .19, PCLOSE=.05), SRMR=.12).

Bouted MVPA. The hypothesised model showed poor fit to the data ($\chi^2(8)=60.03$, $p<.001$, CFI=.45, TLI=-.03, RMSEA=.28 (90% CIs: .22- .35, PCLOSE=.00), SRMR=.16). As with the total MVPA model, five modification indices were reviewed and a direct path from SE to QoL psychological (M.I.=10.05) and a covariance between the two QoL error terms (M.I.=30.62) were added. The final model (Figure 6.3) showed an acceptable fit to the data ($\chi^2(8)=9.68$, $p=.14$, CFI=.96, TLI=.90, RMSEA=.09 (90% CIs: .00- .18, PCLOSE=.23), SRMR=.08). Path coefficients were in the expected direction. Greater distance of facilities ($\beta=-.37$, $p<.001$) and lower SE ($\beta=.21$, $p=.04$) were associated with more minutes of daily bouts MVPA. In turn, more bouts MVPA predicted better physical function ($\beta=-.35$, $p<.001$) and better self-reported physical QoL ($\beta=.24$, $p=.02$). SE was the only significant predictor of psychological QoL ($\beta=.31$, $p<.001$). Interpretation of the significant path coefficients suggests that for 1.85 units increase in ratings on the SE scale (that is one standard deviation), bouts

MVPA is expected to increase by 2.44 minutes per day (or 17 minutes per week). Similarly, for each 6.4 unit increase in scores on the Facilities Distance ALPHA subscale, daily bouted MVPA is expected to decrease by 4.09 minutes, equivalent to 29 minutes per week.

The bootstrap-generated, 95% BC CIs revealed significant indirect effects of facilities distance [95% BC CIs: .07, .21] and SE [95% BC CIs: -.16, -.02]) on physical performance. Also, of facilities distance [95% BC CIs: -.22, -.05], SE [95% BC CIs: .01, .16] and bouted MVPA [95% BC CIs: .03, .22] on physical QoL. The proportion of the variance explained by the model variables was 17.9% in bouted MVPA, 12.4% in the physical function, 12.3% in psychological QoL and 20.9% in physical QoL.

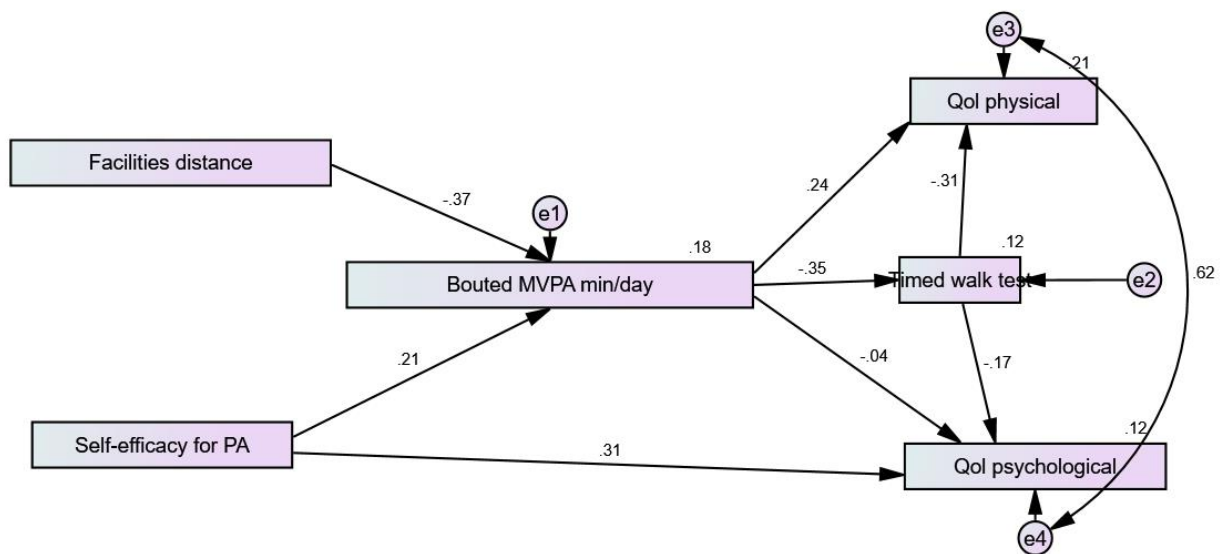


Figure 6.3 Modified path model for daily bouted MVPA (good fit)

The hypothesised model for total MVPA, modified with two additional paths, one direct from self-efficacy for physical activity to psychological quality of life (QoL) and a covariance between the two QoL error terms. The model fit remained poor even after the modifications. The standardised path coefficients are displayed on each path.

MVPA=moderate-to-vigorous physical activity; QoL=quality of life; e1- e4= errors terms associated with each observed variable, which are used in path models to represent random measurement error and error arising from specific variable characteristics (Byrne, 2016, p.10)

Discussion

Grounded in psychological (Bandura, 1986) and ecological (Sallis et al., 2006) frameworks of PA behaviour, an integrated path model from PA self-efficacy and neighbourhood facilities to physical function and QoL via daily MVPA (bouted and non-bouted) was tested in a sample of individuals with hip or knee OA. The bouted MVPA model demonstrated an acceptable fit to the data following two modifications, including a direct path from SE to psychological QoL. Significant direct effects of facility distance and SE on MVPA and indirect effects on physical function and physical QoL were found. Bouted MVPA in turn predicted better physical function and physical QoL. In addition SE predicted better psychological QoL. The respective model for total MVPA did not show a good fit to the data.

Implications of the integrated model of MVPA correlates

The findings support the expected links between the examined variables, namely PA SE and facilities distance as predictors of bouted MVPA, physical function and physical QoL as MVPA associated outcomes.

With regards to the MVPA predictors used in the model, both SE and facilities distance were significant and meaningful correlates in the bouted model, explaining about 18% of the variance in MVPA. Although this proportion is small, it should be noted that the model does

not account for all different levels of PA determinants mapped by the ecological model or more constructs within the SC model. The latter, for example, in a systematic review have been shown to account for 31% of PA variance (Young et al. 2014). Nevertheless in light of recent evidence of a graded PA- physical function and QoL association in lower limb OA (Dunlop et al. 2011; Sun et al., 2014) and “the more MVPA, the better” with regards to general health outcomes (Jefferis et al., 2019), this association is not negligible. The same is the case for an expected daily increase of 2.44 minutes in bouted MVPA for a standard deviation increase in SE, considering the 9.19 daily mean for this sample.

Current findings are in line with existing research examining PA SE and facilities distance in older adults and arthritis populations. In this sample higher self-efficacy to overcome PA barriers were related with higher levels of bouted MVPA. Findings from prospective study designs have revealed a positive effect of baseline PA SE or SE change on PA at 3 months (arthritis) (Mielenz et al., 2013), 20 weeks (older adults) (Sperber et al., 2014) and 18 months (arthritis) (Phillips and McAuley, 2013), all reporting small-to-moderate SE effects. The positive indirect effects of PA SE on physical function and physical QoL also complement prospective data on lower limb OA that reveal a protective effect of arthritis SE on functional status (Sharma et al., 2003). Facilities distance, on the other hand, was correlated with MVPA irrespective of accumulation pattern and also had a stronger correlation with bouted MVPA than SE. With an average facility distance corresponding to 11-20min walk, on a scale ranging from 1-5 to >30 min, it appears the farther local shops, services and recreational spaces were from participants' home, the less likely participants were to walk there, at a moderate or faster pace. Timmermans et al (2016) found that high light PA (760-2019 cpm, vertical axis) was positively associated with distance from retail and health care services in participants with lower limb OA, whereas MVPA had no association. This does not contradict

our findings, since many of the services examined in Timmernams's study (large supermarket, grocery store, GP, physiotherapist) had an average distance of 0.5km, translating into 6-min walk with an easy walking pace. It is worth noting that SE and environmental variables are usually examined independently rather than simultaneously as in the present study. Drawing from the ecological model and consistent with findings on older adults (Barnett et al., 2017; Booth et al., 2000) and the general UK population (Adams et al., 2013), the present findings hold promise for the inclusion of environmental variables in future research on PA in OA along with psychosocial. Although admittedly physical environment is of the least easily modifiable factors, accumulation of sound research evidence could inform better future urban planning for example.

An interesting finding in the present study was the observed significant and positive PA SE-psychological QoL correlation. Psychological QoL not being directly predicted by PA (Netz et al, 2005; Rejeski and Mihalko, 2001), but indirectly via PA SE (MCAuley et al., 2011 2013; Paxton et al., 2010) has been previously found with self-reported PA in older adults. This potential mediational role of SE in the PA-QoL relationship was not tested here. The belief in one's ability to overcome PA-related barriers might reflect positive mastery experiences and/or a more dispositional trait, like self-perception or coping, with "spill over" effects on life satisfaction. This might also be particularly relevant to a debilitating condition like OA.

MVPA as more than one behavioural pattern

A noteworthy finding is the difference in model fit for bouts and total MVPA, i.e. accumulation in bouts of minimum 10 minutes versus sum of every MVPA minute irrespective of bouts. This might be partly explained by the PA SE operationalisation, which focused on bouts physical activity including an example of 30-minute walk five times a week- also supporting the task-specific nature of SE (Bandura, 1997). However, in conjunction with the

differences in mean daily minutes- 74.53 for total, 9.19 for bouts- and in the correlations of MVPA with SE, physical and psychological QoL, the findings suggest that bouts MVPA is a distinct behavioural pattern. Longitudinal and cross-sectional population studies with middle-aged and older participants comparing different ways of MVPA accumulation conclude that the way objective PA is accumulated does not make a significant difference in its positive effects on key health outcomes such as all-cause mortality (Saint-Maurice et al., 2018), multimorbidity of chronic diseases (Loprinzi et al., 2016) and metabolic syndrome (Clarke and Janssen, 2014). In these studies total and bouts MVPA were compared, with the exception of Loprinzi et al. (2016) who used bouts and sporadic MVPA, clearly defining sporadic as total minus bouts minutes. Robson and Janssen (2015) found strong associations of embedded MVPA, that is, sporadic MVPA occurring within bouts light PA, with metabolic syndrome in adults, although bouts MVPA was still a strongest predictor. The present study suggests that there might be something different in bouts MVPA when it comes to psychological outcomes, given the trend for more positive links with physical, psychological QoL and PA SE than total MVPA minutes. Such a link would have implications for selection of outcomes in future research. For example, for an intervention targeting an increase in sporadic-which corresponds to “lifestyle”- MVPA might need a tailored measure of SE and to independently examine bouts and non-bouts MVPA effects on physical health and well-being outcomes. It should be noted though that a causal pathway cannot be inferred by the correlations observed in the present study. Future prospective research including randomised controlled trials, is needed to provide evidence of a causal link.

Strengths and limitations

This study brings PA behavioural research in lower limb OA a step forward in more than one ways. First, it tested the joint contribution of two established psychosocial and

environmental MVPA correlates, highlighting the role of both. Second, it used objective MVPA based on cut points validated for older adults. Third, the study made a distinction in MVPA patterns, specifically bouts versus total, rather than viewing MVPA as a single, homogenous behaviour. Fourth, the present research included both physical function and QoL, along with MVPA as outcome variables.

An important limitation of the study is its cross-sectional design, which does not allow causal inferences. However, in behavioural research bi-directional relationships (reciprocal determinism), rather than absolute causal factors is what we usually encounter (Bauman, 2002; Keller et al., 1999). In people living with osteoarthritis for example, maintaining a physically active lifestyle predicts better physical function (Dunlop et al., 2011), but also evidently better physical function enables physical activity. The hypothesised sequence represents a snapshot of a dynamic and complex phenomenon like PA behaviour (Keller et al. 1999) and associated outcomes. Another important limitation is the sample size. The minimum recommended sample of five cases per model parameter, which is $5 \times 15 \text{ parameters} = 75$ for the present study (McCallum, 1996), did not allow for inclusion of more motivational variables in the model. The present sample size also did not permit an examination of stratified models by demographic and disease related characteristics. Larger samples are required to examine more expanded models (Bentler and Chou, 1987) and consider the testing of potential interactions between physical environmental, social and individual-level variables (Kerr et al., 2010). Large sample sizes are also required when accounting for error in each variable by testing a measurement model as well as the structural (Bentler and Chou, 1987; Streiner, 2005).

Lastly, the 20m timed walk test was used to assess physical function. A battery of tests including sit-to-stand, fast-paced walk test and stair climbing test (Dobson et al., 2013) has been suggested as a valid option in lower limb OA. However, the choice was made based on

methodological and practical considerations, in particular walking being the most common PA in lower limb OA (Sliepen et al., 2018), gait speed being a disability predictor in older adults (Abellan van Kan et al., 2009) and the point that the data collection needed to take place within clinic space, during clinic hours. Lastly, the study participants were on average quite active, with more than average physical function and low levels of anxiety and depressive symptoms (not reported here) and represent less than 25% of eligible OA patients who were invited to participate. Therefore the findings might not be generalizable to individuals with OA who are at a worse state physically and psychologically. However, OA severity (based on self-reported descriptions) covered a wide range of patients, from non-symptomatic to eligible for joint replacement.

Overall the study findings support an integrated PA behavioural model, from socio-cognitive and physical environmental factors to physical function and quality of life via the mediation of (bouted) MVPA in lower limb OA. These findings have implications for future studies. While theory driven, the majority of studies on PA behaviour do not account for physical environmental factors. Their influence might also pass unnoticed from individuals. For example, in the systematic review reported in previous chapter, physical environment was rarely brought up in qualitative studies as a PA barrier or facilitator. Accumulation of research evidence on the role of physical environment might lead to better urban planning in the long-term, as is the case with few cities worldwide that reinforce “active aging” programs, like Manchester in UK. On the other hand, our findings do not diminish the value of addressing psychological factors, as these might be relevant to outcomes other than physical health, such as life satisfaction. A point is also made regarding bouts MVPA as a distinct behavioural pattern with regards to its predictors and outcomes. Future research with larger and more

representative samples in needed to advance our understanding of MVPA patterns in this population.

CHAPTER 7

PHYSICAL ACTIVITY AND SEDENTARY EXPERIENCES IN PEOPLE LIVING WITH HIP AND KNEE OSTEOARTHRITIS: A BALANCE BETWEEN BEING CONSTRAINED AND TO KEEP ENJOYING LIFE

Introduction

The recent PA recommendations by the European League Against Rheumatism (EULAR) for people with hip and knee OA state that PA promotion should be an integral part of OA healthcare throughout the course of the disease and in line with the PA recommendations for the general population (Rausch Osthoff et al., 2018). This is an addition to existing EULAR recommendations for OA treatment, which focused on structured exercise. Although research has focused on the development and testing of feasible interventions for exercise promotion (Williamson et al. 2015), when it comes to lifestyle PA, what behaviours should be targeted and how these can be best promoted is still not fully understood in OA. When focusing on PA and SB change, it is important not to lose sight of the individuals and the over-arching life context where these behaviours take place.

Pain during movement and mobility limitations are the main manifestations of OA. These are also the patient-reported outcomes most often assessed in OA research (Lundgren- Nilsson et al., 2018). Since bodily movement is integral to our living experience, OA can have a negative effect on every life domain, impacting the person's physical and psychological quality of life. Previous qualitative work in people living with lower limb OA provides an account of an existence marked by pain (Maly and Krupa, 2007; Pouli et al., 2014). "Living with hurting", "living with difficulty doing" (Baird, 2000), "the psychological impact of arthritis: it affects everything you do, it affects everything you want to do" (Harris et al., 2015) are relevant findings eloquently and poignantly reflecting this experience.

Drawing from sociological perspectives on illness and disability, Sanders and colleagues explored the significance and consequences of hip and knee OA in older age and discussed the portrayal of OA as a disruption in a person's life biography (Sanders et al., 2002). Negative impact on one's sense of self, such as devaluing self-perceptions (Maly and Krupa,

2007), is another aspect of the experience of living with OA. Based on patients' and HCP's accounts of OA effects as examined via a concept mapping methodology, Busija et al. (2013) constructed a model of the personal and societal burden of OA. The components of the model included physical limitations, physical deconditioning, fatigue, physical distress, psychosocial distress, sleep disturbances, financial hardship and loss of productivity. They emphasised the "interplay of physical and emotional factors" and discussed how physical distress and compromised physical function leads to psychosocial problems (Busija et al., 2013).

In this context of pain and disability, PA promotion becomes a challenge. However, it is not the whole picture. In the face of OA disability and distress, individuals also try to find ways to cope with the symptoms and impact of their disease. Such psychological processes have long been identified in coping with chronic illness (Felton and Revenson, 1984; Lazarus and Folkman, 1984). For example, in Sanders et al.'s (2002) study referenced above, OA had become normalised and incorporated in participants' personal history. Harris et al. (2015) stress the psychological burden of OA in older women, especially as the pain and limitations progress over time, but also discuss their attempts to adjust on a "day to day" basis.

So how do PA and sedentary behaviours (SB) fit within the OA experience? Undoubtedly, a physically active lifestyle with sufficient PA levels and not extensive ST should be part of self-management in OA (Rausch Osthoff et al., 2018). Qualitative inquiry is appropriate for an in-depth exploration of people's PA and sedentary experiences when living with OA. The systematic review of qualitative evidence on PA barriers and facilitators presented in Chapter 3 illustrated two distinct patterns of experiences, beliefs and corresponding behaviour relating to PA in OA. Those who did not adhere with PAs were overwhelmed by their physical barriers and distress. They also had no positive experiences and beliefs about PA. Those who tried to remain active on the other hand, had a positive attitude as well as

positive experiences and beliefs regarding benefits of PA. These findings drew mainly from studies on the perspectives of people with OA in regard to exercise-programme participation, rather than lifestyle PA. Hawker et al. (2008) explored pain experiences in hip and knee OA. One of their findings was that the experience of aversive acute pain episodes resulted in PA avoidance (Hawker et al., 2008). PA behavioural outcomes such as the latter (PA avoidance) are not thoroughly discussed in qualitative inquiries on OA experience, that is, the studies do not focus on PA behaviours.

To date and in studies using qualitative and quantitative methodologies, PA in OA has mostly been understood in terms of barriers and facilitators and in relation to structured exercise participation. This is problematic in two ways. First, tailoring an interview schedule and subsequent data analysis to barriers and facilitators provides a limited insight into the person's experience, most likely focused on participants' conscious and logically processed perceptions of why or why not they engage in PA. Secondly, the term PA includes a vast array of activities, namely any bodily movement during waking hours. As was shown in Chapter 6, even when using the criterion of intensity level (e.g., light vs moderate-to-vigorous PA), we see that PA is not a homogenous behaviour but consists of various patterns (e.g., bouts, sporadic).

With regard to SB, qualitative studies with older adults have showed that negative perceptions around sitting and its impact on health have been linked to increased motivation to reduce ST (Greenwood-Hickman et al., 2016) and engagement in a physically and socially active lifestyle (McEwan et al., 2016). However, contradicting evidence, such as negative perceptions of SB among inactive older adults, have also been found (Grossman and Stewart, 2003). SB have been also described as meaningful and enjoyable (Greenwood-Hickman et al., 2016; McEwan et al., 2016). Although qualitative studies have not been conducted in people with OA, pain has been found to be an important determinant both of sitting and interrupting

ST in older women (Chastin et al., 2014b), whereas in a sample of women with rheumatoid arthritis SB was a response (Thomsen et al., 2015).

Study aims

The present study aimed to better understand PA and SB of people with hip and knee osteoarthritis in the broader context of their daily lives and individual sense of well-being (and ill-being).

Specific study objectives were to gain insights into:

1. How PA and SB are actualised, i.e., what people living with OA do in terms of PA and ST in their daily lives.
2. How PA and SB are experienced, i.e., is engaging in these behaviours viewed as more or less positive and/or negative and why.
3. What keeps this group of people physically active/ sedentary.
4. The potential interplay between PA/ ST and the realisation of well-being and/or “ill”-being.

Methods

Study reporting is informed by the Consolidated Criteria for Reporting Qualitative Research statement (Tong et al., 2007).

Ethics

Ethical approval was gained from the Health Research Authority and the West Midlands Research Ethics Committee (IRAS ID 185665; appendix 6.1 for letters of ethics approval) and

received portfolio support was adopted by the NIHR Portfolio (Central Portfolio Management System ID 32651).

Study Design

A qualitative research design with face-to-face semi-structured interviews and an interpretative underpinning epistemology was employed (Bazeley, 2013).

Participant Selection

Participants were adults with a diagnosis of symptomatic hip or knee OA. They were a sub-sample of the quantitative research study participants described in Chapter 4. Participant selection was based on purposeful sampling aiming to include a representation of age groups (younger and older adults), gender and disease duration (recent, chronic), OA severity (based on personal account of the OA effect and HCP's proposed treatment) and PA levels and patterns (work, leisure). PA levels and patterns were self-reported and the respective accelerometer data for each participant were reviewed after completion of the interview process. Sample size was decided on the basis of data saturation and taking into account the available resources and research purpose (Baker and Edwards, 2012). A minimum analysis sample of 10 participants with a stopping rule of two more was adopted, which is a well-supported practice among qualitative researchers (Francis et al., 2010; Guest et al., 2006).

Settings and Procedures

The study was conducted in secondary care (Dudley Group of Hospitals, Nottingham University Hospitals NHS Trusts) and community (University of Birmingham) sites. Participants were invited to take part in the study at the end of their first or 6-month follow-up visit for the accelerometry study. If interested, they were given a Participant Information Sheet and an interview appointment was arranged (appendix 6.2 for the study poster, PIS and

informed consent form). A second, confirmatory contact was made one day prior to the interview. Twelve interviews were conducted. One who initially agreed, did not participate due to family circumstances. Interviews lasted for 30-60 minutes (mean 43 minutes). Field notes were written following each interview on discussion that might have taken place but not recorded (e.g., after turning the audio recorder off) and personal impressions and comments regarding the interview process (Bazeley, 2013).

The interview schedule was developed based on the study objectives and drawing from SCT and SDT constructs, thus including questions on the feelings around PA experiences (positive/ negative), beliefs about PA in OA, role of others in participants' PA habits (Bandura, 2000b; Deci and Ryan, 2008). The schedule was reviewed by the research team, who ensured that all main aspects of the models are inquired about, such as the role of important others. Next, the interview schedule was piloted with three younger adults (one healthy active and two sedentary with on-going musculoskeletal conditions), which led to few changes removal or amending of questions that were perceived as repetitive. Feedback on the interview was next given by a health psychologist (EH) and an orthopaedic consultant nurse, which led to further review involving change of wording to make the questions comprehensible to a lay audience. The interview included questions about the diagnosis, the effect of OA on participants' lives, engagement in PA and sedentary behaviours and whether these were positive or negative experiences, personal meanings of well-being and illness. To facilitate more in-depth accounts prompt questions were asked where necessary regarding particular aspects of their narratives such as perceptions, thoughts, feelings, strategies etc. The final version of the interview schedule can be found in Appendix 6.3. Additionally, during the interview brief evidence-based information was provided to participants (NICE, 2014), relevant to questions they had on PA

in OA or to behavioural patterns that were absent from their daily routines, e.g., breaking up ST.

Data Analysis

Consonant with the exploratory nature of the present study, the analytical approach of choice was inductive thematic analysis (Braun and Clarke, 2006; 2013) to enable the formulation of themes linked to the data rather than stemming from pre-defined, theoretical frameworks. Interviews, transcriptions and data analysis were conducted by the same researcher, with the exception of three transcriptions which were undertaken by a professional transcriber due to the researcher's time limitations. Open-source media player software (VLC media player) was used by the researcher for the verbatim transcription of the audio interview records (Appendix 6.4 for an interview transcript example). Interview transcripts were read through several times and memos were kept along with the field notes. To comply with anonymisation, each participant was given a pseudonym starting from the letter of the alphabet that corresponds to the order of their interview, for example, Anna, Brian, ..., Kate.

The transcripts were entered and analysed in NVivo 12. The first step was open coding of all text from ten transcripts, unit of analysis ranging from a short phrase to several lines of text that expressed the same concept. Two transcripts were kept aside to be analysed later for referential adequacy. Next, codes were grouped together based on similarities in the meaning and a first provisional framework of themes was formed. A team debriefing followed, involving experienced researchers from the fields of health psychology, sport and exercise psychology and physiotherapy. Themes were reviewed following the debriefing. The two remaining transcripts were then analysed, which did not substantially add to existing themes indicating that data saturation was reached.

The researcher went back to re-reading each interview, identifying prominent themes and comparing these with other interviews. Because a satisfactory theme organisation was not achieved at this point due to the complexity of the themes, the researcher repeated the analysis with pen and paper. Meaningful units of text relevant to the research questions were coded and themes were identified. Next, the themes were reviewed quote-by-quote to ensure that the thematic headings reflected the issues discussed. Themes were then combined into greater and overarching themes. Another team debriefing followed and the findings were deemed meaningful and grounded to the data. The last stage was writing up of the findings. It should be noted that data on objectively measured PA and ST drawn from visit 1 of the accelerometry study are reported here for informational purposes.

Trustworthiness

The sample selected was appropriate for the study, that is, participants had lived experiences of the subject under study. The analysis was also grounded in the data and an audit trail, evidenced by the quotes provided, links back to the data (an interview transcript example can be found in Appendix 6.4). Several processes were further undertaken to ensure trustworthiness (namely credibility, transferability, dependability and confirmability) of the findings: (1) prolonged engagement: before commencing data collection, the researcher spent significant time in Orthopaedic Clinics recruiting patients with OA for another project. During this time, she had the opportunity to engage in meaningful conversations with both patients and HCP and gain a better understanding of the issues patients bring to consultation and the consultation process itself; (2) peer debriefing: as described in the previous section, team meetings took place during the analysis and the process, raising issues and findings were discussed. This informed subsequent analysis; (3) external audit: a professional, health psychologist, experienced with qualitative methods and not involved in the research project was

brought in and provided feedback at various stages of the project, in particular interview schedule, interview conduct, initial coding, theme formation and final output; (4) thick description: the analytical process and findings are presented in detail; (5) negative case analysis: where individual cases presented a deviation from a theme concept, these were described; (6) reflexivity: the researcher conducting this study acknowledged that her personal experiences and background are embedded in her perspective and research outcome. An account of this background is provided below.

The researcher has studied Psychology and Sport Sciences (UG), had training in qualitative methods at undergraduate and postgraduate levels and has undertaken qualitative projects as a research associate. She has also practiced Cognitive-Behaviour therapy as a trainee (M.Sc. Social-Clinical psychology), has an intrinsic interest in understanding (human) behaviour and views PA as an integral part of well-being. This led to including an inquiry of well-being in this study, although she considered more likely to get a 'gloomy' account of how PA is experienced when living with OA, along the lines of existing literature. The researcher has also experienced several joint injuries and pain, two of which marked very painful and distressing periods of disability with a severe impact on daily life and sense of self. During her interaction with the participants the researcher felt proximity, compassion and genuine interest to understand their experience. She could also identify with aspects of their experience. There was no pre-set idea about how to view the participants' accounts, which is why it took two "rounds" of analysis for the reported patterns to emerge. After completion of the analysis, the researcher's own past and present PA experiences made better sense as a conscious effort to keep as active and pain-free as possible at present without compromising the ability to be active in the years to come.

Table 7.1. Participants demographic, OA-related, physical activity and sedentary time characteristics

Name (age)	OA chronicity	TJR an option	Had physioth/py	Joint	MVPA (min)	LPA (min)	ST (hours)
Anna (43)	Recent		✓	Hip	27	84	14.8
Brian (52)	Chronic		✓	Knee	43	79	13.3
Chris (49)	Recent			Hip	102	147	10.6
David (63)	Chronic	✓		Knee	40	71	12.7
Emma (55)	Recent		✓	Hip	21	74	12.1
Florence (49)	Chronic		✓	Knee	39	77	12.6
Gail (55)	Chronic	✓		Knee	50	182	12.2
Helen (45)	Recent			Hip	47	92	12.6
Irene (49)	Chronic	✓		Knee	71	55	12.3
Jane (74)	Recent		✓	Hip	35	63	12.6
Kate (70)	Chronic			Hip	23	85	12.0
Liam (79)	Chronic	✓		Knee	32	115	12.4

Recent refers to seeking medical help or receiving a diagnosis within the last three years;

TJR= total joint replacement, meaning it has been offered as a treatment option by the consultant; had physioth/py= had physiotherapy; joint= joint of primary concern; PA= physical activity; LPA=light PA; MVPA= moderate-to-vigorous PA; ST=sitting time

Findings

Twelve individuals with hip or/ and knee osteoarthritis took part in the study, eight from secondary care and four from the community (Anna, Jane, Liam, Kate). There was good representation of both genders, younger and older age groups and disease severity. Anna, Jane, Kate and Liam were recruited from the community and the rest from secondary care settings. A summary of participants' demographic, disease-related characteristics, PA and ST (accelerometry-assessed) is provided in Table 7.1.

The analysis of participants' narratives revealed two overarching themes: Physical Activity Negotiations and Sedentary Behaviour Negotiations. The overarching theme of PA Negotiations included the themes *Valuing Mobility*, *The Burden of Osteoarthritis*, *Keep Going*, *The Feel-Good Factor*. The overarching theme of Sedentary Behaviour Negotiations included the themes *The Joy of Sitting*, *A Lot Is Too Bad*, *The Osteoarthritis Confines*. Two more themes were overlapping between PA Negotiations and Sedentary Behaviour Negotiations: *The Life Context* and *Finding a Balance*. The majority of the themes derived from all participants' narratives. The respective number of interviews is indicated in the parentheses. Themes are illustrated with rich reference to original quotes. The “[]” symbol is used where parts of the quotes were omitted to avoid repetition or overexpansion of expressed ideas, without breaking the narrative flow. An overview of the emerging overarching and main themes is presented in Figure 7.1.

Physical Activity Negotiations

PA, either as an experience or as behaviour, can by no means be explained or understood in a simplistic way in the expressed views of this sample of individuals living with lower limb OA. A number of diverse and sometimes contrasting factors are operating, interacting,

negotiating continuously to shape each behaviour and PA engagement. The themes and subthemes offer an insight on the main aspects of these negotiations.

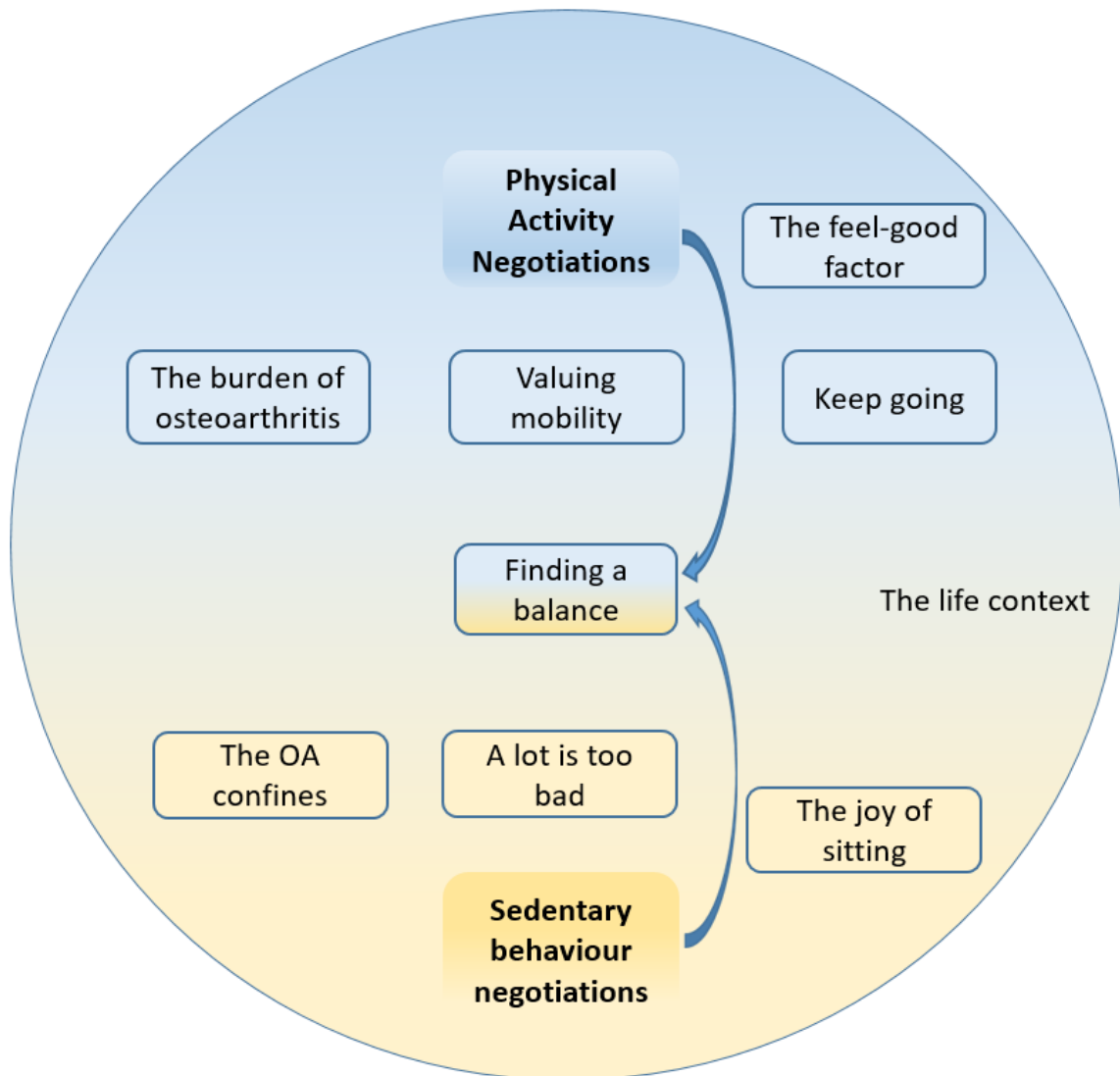


Figure 7.1 A visual representation of the overarching and main themes

Valuing mobility: from preservation to life enjoyment (12)

Being physically able to do daily activities and being physically active emerged as a highly valued feature of daily life in participants' narratives. Life satisfaction was related to activities of daily living and physical ability was at its core for almost all participants.

The more disabling OA symptoms they experienced, the more central that mobility became a part of their conscious experience and sense of well-being. For Emma who could not make any movement or keep any posture (even in bed) without pain at the time of the interview, pain, distress and a life "on hold" were central to her narrative. Irene often experienced weeks of "horrendous" pain when her knee would dislocate, but she was doing her daily activities and had a sense of well-being outside these flare-ups.

Like if I go walking now, if I have got to go out of a stile or anything, I'm not like a normal person. I can't bend my knee as good as some people to get off the stile. But as long as I can still do it that's fine. [] As long as I can get- do the daily things and walk to work, do my housework, and- I'm, I'm happy. (Irene, 49)

For others, a glimpse of disability during a flare-up amidst a life with milder OA symptoms awakened a realisation of how valuable mobility is to them and the need to preserve it. Avoiding an experience perceived as more adverse and to keep enjoying life as it is had then become motives for being physically active:

Actually losing that mobility makes you realise you take things for granted. [] Because one day you can be perfectly fine and then the next day got out of bed and could hardly move. [] And I'm thinking to myself, I just don't know how to cope if that was a permanent thing. I do things important to try to keep mobile, try to keep exercising for as long as I can really. (David, 63)

Four participants stated straightforwardly how important it was for them to maintain independent living (Emma, Gail, Jane, Liam):

The most awful thing I can imagine is being- relying on someone else. I think if you reach a point-like my mother reached- when you need someone to go to the toilet, help you get into the car or be real chair-bound, I think I don't want, I wouldn't want to live like that. [] I want to remain independent for as long as possible. (Liam, 79)

For three participants, being physically active had an existential meaning; i.e., being active was making the most of their lives and reflected their way of living (Chris, Kate, Liam). Potential disabling OA effects were not as (or not at all) prominent in their narratives. Interestingly, they did mention life changing experiences they had regarding ...:

I just enjoy life! And I got to the age now where I'm watching most of my friends slowly disintegrate and start losing it mentally and physically and I don't want to. I want to keep as active and as bright, positive as I can for as long as I can... (Kate, 70)

To say it nicely, I may as well go. I may as well just go and die basically, simple as that. If I can't be active, that's it. I won't want to do anything else. If I can't do sport and move around, it's not worth me being on the planet, because that's what I've done all my life, since the day I was born. (Chris, 49)

Participants also expressed their worries for the future with regards to the impact OA could have on their mobility, which is discussed in the following theme.

The burden of osteoarthritis (12)

Living with OA meant living with mobility limitations and pain, although symptom severity varied from one individual to the other. In turn, experiencing constraints, disability and

pain had a negative impact on participants' well-being and was a source of distress. The highest volume of quotes were captured under this theme. It comprises three subthemes: *Limited*, *It Drags You Down*, and *Will PA Help? Will PA Make it Worse?*

Limited

All participants were experiencing some sort of inability in doing PAs although the degree of impact varied greatly. The majority talked about a list of activities they could no longer do from basic daily activities like walking up and down stairs, interference with work, to leisure and sports. All had given up activities they enjoyed because of the direct (experienced) or expected long-term impact of PA on their mobility. At times of flare-ups, mobility would suffer more and then would become better.

Some things I can't do, like up and down stairs I have to, one leg at a time, or coming down I have to come one leg at a time. I can't get in and out of the bath, I have to use a shower. [] But I used to walk a lot more than I do now. Yea, I'm limited now.
(Gail, 55)

It affects it [life] quite a bit really. Not so much now, after I've done the hydrotherapy, you know, cause I've got a better range of movement. When it was really bad it was a struggle to get in and out of the bath, [] I couldn't lift my legs to put socks on, shoes and like trousers and that. (Florence, 49)

Irene and Emma experienced extreme limitations on a permanent basis.

Sometimes it's not too bad. I can't do stairs particularly very well, they are pain, [] I can't do heavy or anything heavy going upstairs any more. Then it just depends on if my knee gives way. Then once it gives way, I have weeks when I can barely walk of the pain. So sometimes it's not too bad and then I have bad times. (Irene, 49)

In Liam, Kate and Chris's narratives, experiencing limitations rarely came up (although they did indicate there were some constraints).

I've always noticed it before because my job, there are plenty of times I've been running, going for a ball or running with the children, and I'm noticing my hip has just gone on me and I've had to pull up... (Chris, 49)

Besides the stiffness and decreased range of movement, pain was the reported underlying cause of limitations in engaging in PAs. Pain was variable in intensity, quality, frequency and impact, ranging from no pain or a constant dull ache to horrendous recurring episodes. Pain distinguished good from bad days.

Basically, I don't really want to take painkillers if I don't have to and so I just put up with a dull ache all the time. (Brian, 52)

...if I was to turn suddenly and catch, I just get a sharp pain and EHHH! [gasps loudly] sort of takes your breath away and then I'm sort of...limping on my left hip until it sort of the pain subsides, until it's back to normal. (Helen, 45)

Some participants described how there is a limit to how active they can be without aggravating their symptoms- if they went beyond this limit, they would suffer.

I do, I do try occasionally, I think, oh it's a nice day today, I'll have a walk, and then I find a couple of days after I'm thinking, UF! I know I've walked! My knees are hurting... (Gail, 55)

There are also subtler shades of being "limited". Most of the participants talked about instances when they did not feel safe on their feet while doing one PA or another. For some, the risky or insecure instances had turned into accidents.

And when I come down the stairs first thing in the morning, I'm a bit nervous because I have to hold onto something because I'm frightened that I'm going to fall because you feel stiff. (Florence, 49)

I did some decorating in the house. I did my own decorating but I had to spread it over time. I did fall off the ladder. It's not a high ladder, it's only a small stepladder, but my knee gave way and I slipped off the ladder. (Emma, 55)

The discomfort, the pain, either unpredictable or constant, and the risk of an exacerbation gave rise to a movement-related awareness. Some participants talked about how they were always conscious of their problem and always cautious when being active.

...I am aaalways, always conscious of it. Even like I said if you go out and you 're dancing and things like that, you know it is always, always there at the back of your mind. []..because I know my knee could go any minute and lock up... (Irene, 49)

It drags you down

Depression, despair, frustration, anger, worry, anxiety- a range of adverse feelings surrounded participants' PA experiences. OA had an impact on their psychological state as much as it had on their body. Besides pain being a very adverse and stressful experience itself, the very fact of not being able to move and do the things they wanted to was highly stressful and hard to cope with. This was unanimously expressed by every participant who had faced, was facing and/ or considered likely to face such a situation in the future irrespective of age:

...the fact that you can't get up and do what you want to do, the fact that you can't just take the dog out and, I think that drugs you down. Mentally it drags you down. [] it drains you. I said to Jen, my wife, a few days ago, I had this bad leg for a few days, I feel it's aged me, even within a few days. (David, 63)

I don't cope with not being able to do what I want to do. It really winds me up and probably when I'm at my most miserable -and I don't get miserable very often- but that's probably when I'm at my most miserable, if I can't play a sport. (Chris, 49)

Having physical abilities far worse than the expected for their age was often discussed by the younger participants as a negative experience. It had an impact on their sense of self, and they felt like “older people”:

Not angry but frustrated, because I'm not old. I see all my friends doing things, going places and I feel frustrated that I can't do it and it gets me down sometimes, that I can't go and do things. [] So the things I used to do and I can't do anymore and I just sit at home. So it makes me angry, it makes me upset. I do get depressed about it. (Emma, 55)

It's strange because it's- you always think of it as an older person's thing. [] and I think, oh God, I'm still young... Young at heart. [pauses] Why? I suppose, you know,... Why? (Helen, 45)

Also hard for participants to cope with, was the interference of OA with their life roles and social self. A few participants described instances at work where they could not perform their duties and how disturbing that was for them:

Don't get me wrong, there are times when you think, why me? And I'm not severe, ok? [] Because it's disheartening to see a very active woman suddenly can't go up the stairs. And especially for my kids. I look like an old lady in their eyes and I don't want them to have this image in their mind about me. (Anna, 43)

The ones [PA experiences] I find worse and embarrassing more than anything are the ones when the patients are there. So if I'm bending down and I have to get up and I struggle to get up, I find those really awful because the patients are there and they feel terrible for me and I did nearly fall over trying to get up from a stooping position. I find it degrading and having to ask other members of staff to do things for me, I find it awful. (Emma, 55)

Other accounts and aspects of OA-related distress, which were discussed by at least two participants, were related to the loss of PAs they could no longer do, feeling alone in what they were going through:

Cause I think sometimes when you are living by yourself you can think that you are unique and that you are the only one who has ever felt like, like you do. And when you talk to other people and realise they've been through exactly the same thing and they've managed to, you know, recover from it... get better... it is very reassuring. (Jane, 74)

They perceived an affected sense of physical self. The latter was usually expressed in subtler ways, most often by women regarding their appearance and attractiveness (e.g., unable to wear heels), while some men referred to physical competence and fitness.

...we've got a full length [mirror] in the bedroom and I looked and I- pff! The knee sort of comes out at an angle and I look terrible! I try not to look to be honest! [awkward laugh]... And- but in shop windows when you are walking past, I look older than I am, I look ancient compared to my age. (Gail, 55)

...all his [son's] friends' dads are probably about ten years younger than me and not all of them but some of them seem a lot fitter, stronger, sportier than I am. I don't want him to be embarrassed. (Brian, 52)

Earlier in his interview Brian had described the high level of fitness he used to have before a series of knee problems that initiated a habit of inactivity.

Besides the distress related to their current experience, there was another facet of mental distress, related to projections of themselves in an unpredictable, more painful and impaired future. The majority of participants talked about their fears for the disabling effects of OA progression (Anna, Chris, Helen, Jane) or of an unsuccessful surgery, especially those for whom joint replacement was the only treatment option left (David, Gail, Irene, Liam).

I think, because what shocked me most about having a diagnosis of osteoarthritis was my age and I'm terrified that... I mean I'm 45 now... [] I was sort of thought of hip replacements and my mobility is going to suffer and, you know, you see people walking around with sticks and I'm thinking- oh, I'm still young... [] And it's, uff, I got that to look forward to? Yes, scared. (Helen, 45)

But I do feel with my arthritis that one of these days it's gonna hit me. Cause it has happened before where for a couple of weeks I could hardly walk. [] So the fact that it's not straightforward [the surgery results] is putting me off a little bit. If I could just have a new knee and that's gonna give me another ten years when I could do most of things physically, then I would say yes tomorrow. (David, 63)

Examples of people disabled or enduring OA pain became frightening scenarios for themselves. Linking back to how they valued and wanted to safeguard their mobility, these

worries were also weighted when making decisions on the best treatment option or PA behaviour.

But... [pause] I think probably the next time I'll go and see him he [the consultant] will put me down on the list [for total knee replacement]. [] I wonder sometimes whether I could carry on and manage with it. [] Cause some people it works for and some people it don't and I'm worried I'll be one it won't work for and I'll be on a wheelchair and that worries me. That worries me that I won't be active. I won't be able to do things, but...[sighs] (Gail, 55)

Will PA Help? Will PA Make it Worse?

Participants who had experienced improvement in pain and mobility after physiotherapy had confidence in the prescribed set of exercises. The rest had not had any discussion with their HCPs about what PAs would be beneficial and what would be harmful for their condition or the PA topic had been mentioned during consultation in a non-helpful or confusing way:

I mean the doctor gave me a load of exercises, but I mean I think it was for people who sort of had a knee injury, but not like arthritis. There are things I couldn't do, like sliding down the wall and bending- I couldn't do half of it. (Gail, 55)

These participants therefore relied on their own understanding and experience of PA/OA. For the majority, this had translated into a balanced active lifestyle, namely adhering to mild PAs and avoiding high-impact ones.

AK: ...so is this [keeping active] something that you came to believe is beneficial for your knees.. Liam: Yes! AK: ...by yourself or you had some advice, some recommendations? Liam: No, no, I just decided that myself. That if I try to be energetic and make my knees work, it would help and it seems to do. (Liam, 79)

However, this group was not doing any structured exercises. They were lacking information about exercise benefits, and seemed to believe that exercises wouldn't be of any help. Information provided by the researcher during the interviews triggered their interest to find out more and perhaps routinely adopt exercises (David, Gail, Helen, Irene). Still it would have to be confirmed by personal experience:

If I was to go on this ARUK website and it was said on that, in black and white, that these exercises are good, these we recommend, these classes can be good for this reason- that would motivate me. If I was told by people who had researched and spoke to people who said, yes this made it better, or, that made it worse, then yes, that would motivate me. It must be ok. Not so much stick your hand in the fire, I wouldn't. (Helen, 45)

David, 63, who had progressed OA but tried to brisk walk daily, commented after the end of the interview how surprised he was that there was no official information or direction regarding this.

For some participants, fear of making their condition worse was translated into avoidance of certain PAs in the absence of HCP advice and personal positive experiences. Unless perceived safe for the joint, a PA would not probably be considered, even when it was enjoyable:

And I thoroughly enjoyed it [canoeing] and I thought I might be doing this again and it is the right thing in the right text of science, I don't mind. (Florence, 49)

Sometimes the line between fear of worsening and fear of pain was blurred.

It's what started me in this spiral of inactivity by having this knee that I felt wouldn't support me. Whether it was an easy excuse then to just... you either then get into the habit of not doing anything, or whether you're worried that by doing something it's gonna make the knee worse, or you're going to get pain and you're trying to avoid the pain so you don't do anything. (Brian, 52)

One exception was Chris, 49, who was keen to go back to high impact sports as soon as his symptoms subsided. Pain and limitations in movement were viewed as a barrier in doing the activities he wanted that could possibly be cleared away. Throughout his interview, he expressed minimal concern about PA making his OA worse:

I'm looking forward to seeing what the injection does, to see if that really frees me up again, but if it frees me up even more I will start playing cricket again. Now I've stopped playing cricket because of the action of playing cricket, but if it did free me up then I would play cricket again. It doesn't bother me being in pain at all really. (Chris, 49)

Keep going (12)

This theme reflects the positive side of the PA experience, which entailed a combination of a positive mentality and proactive engagement with PAs. It consists of three subthemes: *Keep Moving, There Is Always Something You Can Do, Keep Spirits Up: Positivity And Appreciation, Being Active Helps With OA.*

Keep moving, there is always something you can do

Most participants emphatically talked about the importance to “keep moving”. They actually did, literally and metaphorically, as the reference to “keep moving” was commonly accompanied by a statement regarding psychological well-being and coping with their

condition. The alternative was a vicious cycle of physically becoming immobile and mentally getting depressed.

I try- generally don't give up, because there are ways to be mobile. If you give up, that's it. That's the downfall. (Anna, 43)

And I think if you don't try something and you don't do things, you are likely to become, you now, like sort of more down and depressed and that. And you are more likely to do less and less and your arthritis just probably gonna get worse. (Florence, 49)

While participants accepted there are limitations and believed that certain PAs would be inappropriate for their condition, they acknowledged they could still be active.

...if it gets that bad, I'll get into a wheelchair and I'll play wheelchair basketball. I will always do something. There's something that I can do, definitely. (Chris, 49)

Participants talked emphatically about the activities within their abilities which they engaged with, including modified versions, new alternatives or a selection of activities that don't put much strain on the joint. In the case of daily activities finding modifications and alternatives meant sustaining an independent living:

AK: It sounds like there isn't a form of exercise that you feel is safe. Irene: Probably I could do normal swimming, but I'm not a massively great swimmer, [] I find it boring. That's why I walk a lot. I try to walk. I find walking is the best thing for me and I try to walk quite quickly. (Irene, 49)

I'm just trying my best, that's all I can do. I try and find ways of doing it. I was cleaning once and my son said, what are you doing on the floor mom? And I- just sort

of finding my way to the stairs to get up... if I'm really stuck I can't get on the floor, I get on the stairs and then allow myself down [giggle] and then I sort of get around the house sort on me back side. (Gail, 55)

Keep spirits up: positivity and appreciation

Many participants referred to positivity as their life stance or way of coping, to the extent possible. They talked about being positive, not giving up, not letting things get them down, enjoying life. This appeared as a conscious effort and choice and was implicitly or explicitly compared to a miserable existence, which lied at close proximity.

You know, I could be better, but I could be a lot worse...and it's actually looking on the positive. Because I think sometimes, if you are looking at the negative, it pulls you down. [] You can't always see the funny side, but where possible... (Florence, 49)

I am happy! [laughs] Well, I'm getting on a bit so I might as well be happy. (Liam, 79)

Some participants expressed their appreciation of life and their circumstances. They were appreciative of basic, pragmatic things in life or of not being in a worse situation, like having a life threatening disease.

"If I'm thinking about well-being, I think the- my daughter is well, my partner is well, I'm well. We have a roof over our heads, we can pay the bills, you know, we have a reasonable existence... and, you know, we both have good jobs. [] And I don't have any sort of... stress factors, I don't really think, not as much as other people. [] It all just falls into place. (Helen, 45)

...you could really worry you know, I suppose, [] if it goes to really being bad and things like that. But. Cause I haven't got a partner or anything, but- you know, you can go on forever. And again, there is always someone worse, people with cancer and things like that, so in the grand scheme of things it's not that bad. (Irene, 49)

Being active helps with OA

The majority of the participants had experienced improvement in their joint symptoms and general physical function by being active, that is walking regularly, keeping busy with various activities or doing physiotherapist-prescribed exercises. They believed in the benefits of the relevant PA for their OA and tried to adhere to that:

Well, I guess that going up the stairs is strenuous and sometimes painful. But I sometimes feel it's something I got to do. Cause I think that if I didn't go down the stairs, things would not work that well anyway. [] The more- the more I do, the more chance it is not getting worse. And in fact I would say it hasn't gone much worse now for quite a few years. (Liam, 79)

Those who had experienced physiotherapy expressed satisfaction with the results (symptoms, range of movement) and tended to view exercise as medicine. This translated into trying to do the exercises regularly (Anna, 43, Florence, 49, Jane, 74) or according to their needs (Kate, 70).

I'm not a person that runs up to the doctors and say, I have this pain or that pain. I go to my sports injury man and I say, this is what's hurting, how can we put it right? And I'll work and I'll do my exercises to make sure I get it right... (Kate, 70)

In the case of one participant Brian, physiotherapy facilitated breaking a habit of inactivity he had acquired over the preceding years after a series of injuries:

After a year they put me on a physiotherapy programme for about six weeks and that actually kind of encouraged me to try and get back into it. Instead of thinking, oh I can't do something because you were worried about the knee, they gave you the confidence to try to go back out and do it. (Brian, 52)

Those who described having an active lifestyle (such as walking, keeping busy), had no formal advice regarding PA. They were relying on their own positive experience, even contrary to common beliefs about wear and tear:

...to me it doesn't make sense because I would think that walking obviously you continuously using the joints, common sense tells me a lot of cartilage has gone from there, ...even walking has got to sort of aggravate that. But I can only speak from my own experience, which since I've been doing more walking, I haven't had so many problems with my knees. (David, 63)

For some this was confirmed by witnessing others' examples of..., deteriorating due to being inactive or doing well when active:

Well, you see I have the experience of that with my ex-wife. Because she also had a new hip fitted about a year after I did, but she didn't enjoy the pain and so didn't do the exercises [] and then ended up with an embolism through not being active and then she's had another, the other hip fitted very recently. And now because of her chosen inactivity [] she can't walk more than 200 yards without stopping or having a rest. (Liam, 79)

The indirect beneficial effect of PA on OA, through weight management, was also highlighted by a few participants:

...I mean, walking obviously helps keep my weight down, which is another factor. I know definitely that when my weight creeps up my knee gets worse. So I can't afford to get any heavier than I am now... (Irene, 49)

Many participants perceived being active as the best OA management option they had in the pronounced absence of any (better) option offered by their HCP. Especially for those who had so progressed OA that joint replacement was the only option left, but either they were too young for it or there were risks involved:

...the last time I came [to see the consultant] I said, are you sure there's just nothing? Nothing? You know, cause I thought maybe key hole surgery [], and he said, no the only thing is replacement really. And I even said, injections? And he said, I really don't think it would work. So. That's where I am at the minute. [] ...he did actually gave me the knee replacement paperwork and said, you know, it's not advisable to have it done at this early age. (Irene, 49)

The feel-good factor (11)

Almost all participants had experienced and talked about feeling good, physically and mentally, when being active: “Feeling more energy” (David) and “everything sparkling off” (Kate), getting fitter, “the extra spring in your step” (Brian) and being in a better mood, happier. In essence, mind and body were inseparable in their experience. Additional satisfaction came from knowing they do what is good for themselves. Also, from successfully getting themselves to engage in an activity.

I felt that I got more energy and generally it does make you feel more well-being. Because you feel that you got a little bit more energy, you know you've lost a little bit of

weight and you know the exercise is doing you good, so...that in itself makes you feel more positive. (David, 63)

I think I wouldn't be happy if I got at the end of the day and thought, oh I haven't done something or at least have a good enough exercise to make me feel things work properly. (Liam, 79)

Most of the participants also talked about how they enjoyed particular activities from sports to daily activities, which were part of their PA repertoire.

I think it's nice [the Wii fit console game] and it is just bit of exercise and I can do it in my house, how I want, you know... (Florence, 49)

I can walk 14 miles in a day backwards and forwards [in her garden]. You know. [] So as soon as the sun is out, I am outside regardless of the weather, it's rain, snow, you know, I'm outside. I just love being outside. So I just keep busy. (Kate, 70)

Chris would join sports and engage in active coaching even when painful because it was something he loved doing. For the rest of the participants, the feel-good factor while part of their PA experience, was not a key determinant in PA negotiations. A manageable level of pain, confidence that the activity would not be harmful for OA and work or family commitments came first. Helen, who refrained from joining structured PAs for fear of making her condition worse, was nevertheless aware of how good she could feel if...:

And that's it, you should feel good, you always feel good after you've exercised. So that has a positive effect on it as well. (Helen, 45)

Sedentary Behaviour Negotiations

Sedentary behaviours and related patterns such as interrupting prolonged sitting time are also underlain by a complex process. Although discussed in less detail by the participants, they appear as part of a continuum with PA experiences. The three themes under this overarching theme were:

The joy of sitting (12)

All participants talked about sedentary activities they enjoy doing. Engagement in sedentary behaviours was considered quality time for oneself.

Yes, I also like to enjoy breakfast and sit for a while and listen to the radio. If I've got the time, that's very pleasant, yeah. (Jane, 74)

...and a lot of time, when I'm actually relaxing, I've got the dogs by me, so it's sort of nice quality time with dogs and that and I feel like, especially when I'm stroking them and that, it's quite relaxing and therapeutic [laughs]. (Florence, 49)

Or an opportunity to spend quality time with their partners, which they valued as these opportunities were limited.

...at home we are generally catching up on the day and how the day has been, cause we obviously haven't seen each other all day. [] And yeah, in front of the TV and there's always something nice to watch. And again, just spending time together is nice, because we don't really see each other that much during the week. (Helen, 45)

For most it was also a time of physical and mental relaxation amidst a busy or stressful life, usually at the end of the day.

..cause sometimes when you had a stressful day, if it's dark when you go to work and it's dark when you come out and sometimes even when I've been sitting in the day, sometimes mentally it is nice to come home and sit down and relax. Just have a cup of tea and just watch TV. It's like a mental relaxation really. (David, 63)

...It's nice to sit down for a change! [] Who has a negative experience by sitting? An office worker I suppose. (Anna, 43)

Some of their favourite activities were sedentary, like arts and crafts or reading.

I watch TV, I read a lot of books. I do puzzles on me kindle, I've got a kindle and I do puzzles on it. I do a lot of cross stitching- I like my cross stitch. When I get time [] I sit there and do it. (Gail, 55)

And of course, socialising and spending time with friends could be sedentary.

...I do a lot of sitting on a Sunday afternoon, sitting down having a few beers, chatting to my mates and watching television. Because we've got the football on, we sit and watch the football on a Sunday afternoon, it's one of our things, we get down there Sunday and that's it really, I just love doing that. (Chris, 49)

A lot is too bad (9)

Although participants enjoyed sedentary activities, almost all mentioned negative perceptions they had about prolonged sitting and most did not see themselves as sedentary.

I try not to...[sighs] be a couch potato. I try not to... I'm not one of these that sit much, you know, in front of box sets, TVs. (Helen, 45)

Many gave examples of attempts they made to reduce their sitting time. For example Brian, who appeared to be the most displeased with his activity levels among the participants, said:

But yes, I appreciate that most of my life is actually spent sitting down. When I go around to visit people and they say sit down, I'll say no, I sit down all day. So I like to stand up and pace. (Brian, 52)

Some participants particularly expressed their dislike of sitting (Chris, Kate, Liam).

I don't like sitting about too much. So, I do watch television in the evening, but really not for more than perhaps an hour, perhaps even half an hour without getting up and go do something. So, I don't like sitting for a long time. (Liam, 79)

Importantly, a sedentary life style also seem to have an existential load attached to it. That is, time spent sedentary was viewed as a waste of their potential and evidence of a miserable state of being. This was vividly worded in phrases like “sit down and vegetate” (Gail), “sit at home and brew” (Jane), “sitting in the house and feel sorry for yourself” (Anna), which were used to refer to what a person with OA should avoid doing or to what the opposite of well-being felt like.

I have a friend extremely, extremely depressed and she'll lie in bed quite whole day...[] she frustrates me because...she is wasting her life away, you know what I mean? (Kate, 70)

The osteoarthritis confines (8)

Another negative aspect of sitting that most of the participants referred to was that it caused symptom aggravation. As with PA, OA set a boundary to how much sitting participants could do before OA symptoms kicked in:

...if I sit for too long, when I stand up I've really stiffened up. (Florence, 49)

Yeah, if I sit for long, if I sit- with cross stitch I tend to get into it and you keep on and keep at it and then when you get up AAAH! I'm stiff! [laughs] And then I have to get round the house for about five or ten minutes and then I start feeling a bit better. (Gail, 55)

Many participants described how they were frequently breaking up their sitting time to avoid pain and discomfort. For some, this had become habitual:

So you can feel it in your hip, the discomfort, so you know you've got to get up and walk around because you can feel it. If [] Ten minutes it's not quite so but if I've been sitting for over 20 minutes, then it's really uncomfortable. (Emma, 55)

I don't remind myself [to interrupt my sitting time], but it seems to happen naturally actually. And I do like- for instance in the evening I always have a break at 9 o'clock and I go make a cup of tea. [] So I do have little breaks and I sort of eat and prepare food and then I sit and watch the telly again. So I wouldn't say that I sit for prolonged periods. Cause that can be quite painful actually! (Jane, 74)

On the other hand, sometimes participants felt it was necessary to sit down to get relieved from pain and discomfort:

Whereas now, I don't do this job any more, I do have a rest in my day. So when I feel really painful I can actually sit down. (Anna, 43)

Overlapping Themes between “Physical Activity Negotiations” and “Sedentary Negotiations”

The life context (12)

PA and sedentary experiences were taking place within certain social and physical environments. All participants referred to the influence of their life circumstances on their engagement in PA and sedentary behaviours. Some life circumstances, especially type of work and family commitments, left only a small window of choice with regards to PA and sedentary behaviours. Work-related PA was variant in the sample, from sedentary (Brian) to active (Chris, Gail, Helen) with in between combinations of moving and sitting (Anna, David, Emma, Florence, Irene). Still some participants described how they were proactive towards PA:

I have quite a stressful job and I do sit at a desk all day with a computer working with spreadsheets. The only exercise I get in the office is getting up to go and get something off the printer or walking down to the kitchen or something like that. (Brian, 52)

But during my working day, pff!, it would be interesting to wear a pedometer to count how many steps we do, cause we al- always walking up and down the corridors. You can go 2 or 3 flights of stairs, to the lab to get some work, [] go downstairs to get a coffee, back up again, you know, I tend not to take the lifts.[] I just make a conscious effort like that, just to use the stair rather than the lift. (Helen, 45)

Work also influenced PA and sedentary behaviours outside working hours. For example, those working long hours, in shifts or stressful jobs, were more inclined towards sedentary activities at the remaining time of the day:

And I must admit when I have come from a late shift, [] cause... Last night I was lucky I was home around half 8, but if you are a nurse in charge, sometimes you are not leaving work until like quarter to 9 [] And if you are on an early shift the next day, just getting home and I'm thinking, you know, like I would have a quick bite and time for bed. (Florence, 49)

Similar to work, family commitments could involve PA, but could also mean less personal leisure time to join other physical activities:

AK: So, what keeps you active? Gail: Just running around after my family to be honest! [laughs][] I'm just sort of back around keep tidying up after them, it just keeps me going. (Gail, 55)

Brian talked throughout his interview about how difficult it was to schedule gymnasium around his wife's working hours and child commitments. At the same time, he referred to instances when he engaged in PAs with his son:

I do go swimming with him and having a seven year old I do spend a lot of time running around and we go cycling occasionally. I've never been a great cyclist, but the three of us have got bikes and we do go out together and I can keep up with him. (Brian, 52)

Factors like owning a dog, commuting, living in a house with stairs and big garden, a walkable neighbourhood and longer days, positively predisposed towards PA:

...I have a big garden, I can go a long walk without leaving the garden. And I've got a house with stairs so I go up and down the stairs a lot. (Liam, 79)

For the four participants who were dog owners (David, Emma, Florence, Irene), for example, dog walking was part of their schedule and it appeared to be both a commitment and a pleasurable activity.

I do a lot of walking. One cause I don't drive, two, cause I've got a dog. (Irene, 49)

As Irene above, those who did not have a car usually referred to it as a reason for their walking (Gail, Irene, Jane). Those commuting by car on the other hand, tended not to take it into consideration when giving an account of their sedentary activities. One characteristic example was Helen:

... it [sitting] could be 2 hours a day that I'm sitted at work. [] So I'd say sitted for up to 2 hours a day, maybe an hour and a half home at night, but I don't lie down till I go to bed. [later in the interview she said] But also, I feel that I don't have enough time during the week to do that [join a structured PA]. I commute to Birmingham every day [] and that can take 1-1.5 hours' drive each way. (Helen, 45)

Social and physical-environmental circumstances were of course acting synergistically, facilitating (or compromising) PA or sedentary behaviours and could account for the discrepancy between desired and actual behaviour:

But the combination of having a few days when I couldn't exercise because my hip was playing up and then a combination of having to work a little bit later, the mornings being darker- so whereas I was getting up at 6 o'clock about 3 weeks ago,

taking the dog out for a walk at 6, back for 7 o'clock and then into work 7.45-8 o'clock, now the dark mornings are preventing me from doing that. []I felt myself the last 3 days sort of drifting back into not getting out and doing the exercise I'd been doing religiously for the last couple of months. (David, 63)

When I'm at work I'm sat down quite a bit, but I'm also up and down because I have to take paperwork into the factory where I work. So I do walk up and down a lot at work, we've got quite a fairly long factory. And then again I walk back [home]. And then I've got a dog, so I walk the dog when I get back from work. And of course it's housework... (Irene, 49)

Financial issues were briefly mentioned as related to leisure PA choices by Florence and Jane. For Anna though, whose OA acutely appeared while having two physically demanding jobs, it was a decision between taking care of herself and affordability.

I was working in that I mentioned before, morning until 6 o'clock and then I had the night job. So between that I had few hours to rest, house work, sleep, do everything.[] So that gave me really, I was really feeling fatigue, obviously. Super tired, in pain. Not willing to do anything except sitting down when I have 5 minutes. [] So I gave a big break. I still have the night job, which is another bad part of my habits[] But I have to pay the bills... (Anna, 43)

In a subtler way, financial security could enable a stress free living of choice.

Cause I think if you have money worries particularly at this time of life it means that you can't go out and do things and enjoy yourself. (Jane, 74)

Finding a Balance (11)

The majority of participants talked about the need for or a constant attempt to make optimal PA or sedentary choices first, for short-term symptom management; second, for long-term symptom management and preservation of mobility. With regards to temporal symptom management, those with more symptomatic OA described how they had to constantly alternate between sitting, standing and moving, because too much of any triggered pain, stiffness or discomfort. In a way there was a continuum between PA and sedentary behaviours:

The more I sit down, the worse it is... Whereas if I'm active then I don't get this problem, but if I'm doing it for a longer period then my- it's when hip kicks in. (Anna, 43)

Keep as active as possible, you know...Don't sit for too long, don't stand for too long, keep doing as much as you can. (Florence, 49)

With a long-term perspective, participants were trying to find a balance between keeping active without overdoing it, enjoying sitting without sitting too much, enjoying life at present while ensuring the future. This was a process of trade-offs and they did it to the best of their understanding and abilities.

Cause I already do a lot of things and I don't need to do too many others really [laughs] (Jane, 74)

And I'd rather just keep to my normal pattern of walking every day than take the chance of doing the Zumba and [my knee] going off and it goes from under me...So I do miss that, but it's just one of those things... (Irene, 49)

One participant agreed by contrast to the need for balanced PA:

We do know that fitness and doing sport and doing something is better, but I'm sure there's a balance though. There has to be a balance I think and that's one thing I've never got right, that balance of taking a bit of rest when I probably needed rest. (Chris, 49)

Discussion

This is the first qualitative study to explore, in an in-depth manner, how people living with OA experience PA and SB in their daily living. The findings revealed that PA and SB were multifaceted experiences, related to the burden of OA, the need to keep mobile and keep enjoying life, and one's life context. The role each facet played at a given time point was "negotiated", specifically was relevant to the importance of other facets and subject to change, also influencing overt behaviours.

The themes comprising Physical Activity Negotiations, i.e., The Burden of Osteoarthritis, Valuing Mobility, Keep Going, The Feel-Good Factor, revealed that PA experience was inseparable from OA experience, but was also connected to participants' sense of well-being. PA was impinged by OA, but was also a means of coping with it and a means of enjoyment and living life to the fullest. The potential of PA to be a negative experience, painful, distressing and limited within the confines of OA, is a well-grounded finding in OA literature (Baird, 2000; Busija et al., 2013). But the present findings indicate that PA is a positive experience as well, because -in moderation- it was the way to hold on to mobility and move on in a valued and meaningful life. OA was a threat to mobility and had brought in awareness of the value of "being able to do" for well-being. Participants were consciously trying to preserve their mobility and living status for as long as possible. Those who appeared to maintain an active lifestyle, made choices to engage in PA at the present time with an eye on the future. This need for continuation of life in a meaningful way and the future perspective in present

choices has been illustrated in qualitative literature on OA and other musculoskeletal conditions. The concept of “continuation of valued activities” as the end point of behaviour was discussed by Morden and colleagues in a study on self-management of OA-pain and risk perceptions (Morden et al., 2015). In a meta-synthesis on chronic low back pain, the need to “preserve a valued self-identity” emerged as an aspect of participants’ experience alongside pain, loss of way of living and a compromised sense of self (Snelgrove and Liossi, 2013). Even in severely disabling conditions like spinal cord injury, realisation that life had slowed down but had not stopped (“The need for a vision of future life possibilities”) has been found to play a key role in rehabilitation (Whalley Hammell, 2007).

In line with findings in Chapter 3, aspects of the PA experience that emerged in the present study, synergistically laid the foundation for a physically active lifestyle: all participants believed that being active was related to better OA outcomes and/ or a better life; all but one had experienced improvements in their mobility and symptoms by being active. In addition, participants were aware of the positive feelings that surround PA experience itself (The Feel-Good Factor). Their narratives focused on how they kept sufficiently active, a finding which was confirmed by their accelerometer data regarding meeting the 150 min per week guidelines. The one exception, Emma, was in acute pain and was instructed by her consultant not to do any PAs except physiotherapy.

The observed correspondence of personal experiences, beliefs, motivation and PA behaviour is also aligned with existing research and theoretical frameworks of behaviour (Bandura, 1977, 2000a; Leventhal et al., 1992; Ryan and Deci, 2000). Specifically, the Social-Cognitive theory underscores the role of beliefs and self-efficacy, which is greatly influenced by mastery experiences (Bandura 1997, 2000b). Qualitative and quantitative studies have supported the link between PA beliefs and behaviour in OA (Chapter 3) (Dobson et al., 2016;

Hurley et al., 2010; Quicke et al., 2017). Positive PA experiences and beliefs can reinforce each other over time (Rimal, 2001). The central role of the personal value of mobility in PA experience as an impetus to “keep going”, its link to a life fully lived, the appreciation of the “feel-good” factor are consonant with Self-Determination theory (Deci and Ryan, 2000). SDT emphasises the significance of autonomous motivation for sustaining a certain behaviour and subsequently experiencing a related sense of well-being, i.e., fulfilling one’s potential (Ryan and Deci, 2000). Existing quantitative research on arthritis patients has also provided support for the model (Yu et al., 2015).

ST was mostly discussed in relation to a desired way of life: not excessively sedentary (A Lot is Too Bad), but enjoyable in the sedentary activities they chose (The Joy of Sitting). Sedentary behaviours were discussed in relation to OA primarily as temporal symptom management (The OA Confines, Finding a Balance), in particular sitting or interrupting sitting for relief from pain and discomfort, which is in agreement with previously reported findings in older women (Chastin et al., 2014b). Shifting from sedentariness to PA and vice versa was often dictated by OA, which indicates that a behavioural continuum between PA and ST could be relevant to OA. Unlike findings from rheumatoid arthritis patients (Thomsen et al., 2015), being sedentary as a consequence of OA symptoms was not often brought up.

A remarkable finding is that, in the view of the participants in this study, physical and psychological aspects of the PA experience were hand in hand across themes: e.g., physical limitations and immobility coupled with mental distress (The Burden of OA, A Lot is Too Bad), keeping mobile and staying positive (Keep Going), feeling good when being active (The Feel-Good Factor). Sense of well-being was not just a mental state, it was an embodied experience (Valuing Mobility). The concept of embodiment has a long-standing phenomenological tradition (Williams, 1996) and is often encountered in research on musculoskeletal conditions

(Snelgrove and Lioffi, 2013), fibromyalgia (Martinez et al., 2018) and mental health problems (Gyllenstein et al., 2010). The exact mechanisms of physical and psychological interactions are difficult to unravel, but different aspects of the current findings have been supported quantitatively. Data from a longitudinal, national study found that fewer leisure activities, more mobility limitations and stress were associated with future depressive symptoms in older Taiwanese adults (Lee et al., 2012), whereas engagement in moderate-to-vigorous PA was related to less chances of having depressive symptoms in older adults in UK (Hamer et al., 2009). Longitudinal studies have also revealed a protective effect of satisfaction with life (Collins et al., 2008) and positive affect (Ostir et al., 2000) on declines in physical function in older adults. In individuals with OA, the relationship between pain and life satisfaction was partially mediated by optimism (Ferreira and Sherman, 2007). These findings support the relevance of the Biopsychosocial model of health to OA, also shown in Chapter 3, and expand it beyond pain experience and treatment outcome assessment (Hunt et al., 2008; Hurley et al., 2003; Keefe et al., 2002).

Life circumstances (The Life Context) were a significant part of individuals' PA and sedentary experiences. In a sense they set upper and lower boundaries in individuals' choices and could hinder or facilitate PA and ST. Work and family commitments were most often discussed, whereas commuting, seasonal influences and physical environment appeared less often. There are some differences in the way social environment was discussed in this present sample of participants in comparison to existing literature. Compared to the studies reviewed in Chapter 3 for example, although the important role of physiotherapists was confirmed, references to social and other HCP's support were very limited in the interviews conducted. It appears that although social support might be influential for participation in exercise programmes, in the case of lifestyle PA, it comes down to the individuals and their self-

determined motivation. PA negotiations emerged as internal processes, like a dialogue with themselves trying to find what is best to do. Alternatively, the limited contribution of the social environment might reflect individuals who are already motivated and engaged in an active lifestyle. The specific perspective of PA in daily life that this study adopted could account for differences in the reported findings. For example, studies that examined difficulties in work places for individuals with arthritis, have focused on practical, emotional and interpersonal difficulties and task modifications (Gignac et al., 2011; Lacaille et al., 2007). In this study, however, work environment was viewed as one of the daily life settings where PA and ST take place, which allowed for an insight on its influence on these behaviours.

Strengths and limitations

The present study offers an insight into the lived experience behind daily life PA and sedentary behaviours in individuals with hip and knee OA. The findings place PA and ST in the context of OA management, while keeping individual's personal values, present and future well-being into perspective. The findings are based on rigorous data analysis and several actions were undertaken to ensure their trustworthiness, namely prolonged engagement, peer debriefings and review, negative case analysis, thick description and external audit. However, the study has certain limitations. The themes were generated by one researcher only due to availability of various resources (availability, time restrictions), which precluded alternative perspectives. Nevertheless, other processes, reported above, were in place to warrant trustworthiness. All but one participants were sufficiently active in their daily lives. This raises the issue of transferability of the findings to other individuals with hip and knee OA. However, it is the insight into this particular perspective of individuals who remain active despite the physical and psychological burden that was missing from the literature. Another potential limitation is that for practical reasons data analysis took place after data collection, which might

have prevented alternative, informed directions in data collection. The researcher though made a conscious effort to be attentive to what participants brought up and was open to follow new, interesting leads. The interview process was a live and dynamic interaction, which evolved during the study.

Implications for research and clinical practice

The present findings hold implications for future research and clinical practice. Firstly, the views of participants revealed PA as a self-management option can finely align with individual's personal values and sense of well-being. Incorporating this perspective in PA promotion in this population could be a promising approach. Features of such an approach could be a vision for the future rather than solely current pain management and open discussions about potential benefits, harms, appropriateness and trial-and-error processes rather than generic PA prescriptions. Secondly, findings suggest that managing mental distress and remaining optimistic could be important components of successful OA self-management. Individuals' need for psychological support that should be taken into account in health-care. It is likely that for individuals who feel helpless and overwhelmed by pain and limitations, pain management and psychological support should precede PA discussions. Furthermore, one group that could gain great benefit from psychological support was younger women who unanimously expressed distress regarding not only the disproportionate to their age mobility limitations they were experiencing, but also their self-image. There was also an expressed or implied feeling of aloneness in their experience, suggesting that group interventions could be appropriate and beneficial for this group (Rejeski et al., 2003).

Thirdly, acquiring positive PA experiences and thus developing positive beliefs about PA is a key factor to PA engagement. Lastly, the EULAR recommendations are a big step towards PA promotion by integrating PA advice in OA health-care (Rausch Osthoff et al. 2018).

However, implementation of these guidelines requires changes in clinical practice. For example, in secondary care the time assigned for a consultation was five/ ten minutes in the clinics where recruitment took place. Even if this amount of time is deemed sufficient for decisions about eligibility for joint replacement and pain management to take place, it is unlikely to allow for more extensive and potentially effective discussions on PA and sedentary behaviours.

Conclusion

Preserving mobility when living with OA in a not clearly marked path, it is a misty uneven ground and it is a whole-person issue rather than a physical one. The first experience OA patients encounter is pain in movement and the commonest lay belief is that moving “will make it worse”. Most of the participants in this study had moved past that. They valued mobility and were proactively trying to preserve it by keeping active and positive. This was not a linear process, but a constant negotiation of OA burden, the need to feel able and enjoy life and other life circumstances. A balanced outcome included keeping a satisfactory level of PA, without overdoing it and enjoying their ST without sitting too much.

CHAPTER 8

GENERAL DISCUSSION

The importance of an active lifestyle for managing OA symptoms, general health and well-being in people living with hip and knee OA is well established. However, reported physical activity (PA) levels for this population are low, reported sedentary time (ST) is high and there is limited understanding of how to best promote a physically active lifestyle. This thesis aimed to augment the current body of research with regard to the determinants of a physically active lifestyle in people living with hip and knee OA: primarily by identifying physical, psychological and social-environmental factors that correspond to PA behaviours, especially MVPA, as precursors and/ or outcomes; secondarily, by understanding the experience of both PA and sedentary behaviours in the context of living with OA disease and in regard to individuals' personal sense of well-being. A range of methods were employed in this thesis.

Firstly, a systematic review of qualitative evidence on PA barriers and facilitators was undertaken to address a gap in existing knowledge of PA determinants in OA (Chapter 3). Findings revealed an interplay of physical (disease-related), psychological (PA beliefs and experiences, attitude, behavioural regulations for engagement in PA, emotions), social (support from healthcare professionals, significant other social support) and physical-environmental barriers and facilitators to PA. These identified factors were mostly relevant to exercise program participation rather than lifestyle PA. No studies relevant to barriers and facilitators of sedentary behaviours were identified.

Based on these findings a quantitative, observational study examining key psychological and social-environmental correlates of accelerometer-assessed PA and ST in people living with lower limb OA was designed (Chapter 4). As a first step, an important methodological issue in accelerometer-assessed PA was examined, that of PA intensity/ ST classification (Chapter 5). A set of cut points validated in older adults using triaxial

accelerometers (Santos-Lozano et al., 2013; Aguilar-Farias et al, 2014) was compared with a set of cut points commonly used in lower limb OA and general population, validated in young, healthy adults using an older (uniaxial) accelerometer model (Troiano et al., 2008). Besides calculating the respective time spent in each intensity/ ST and meeting guidelines, cut-point comparisons were also made on the basis of associations between the differentially calculated levels of MVPA with health and well-being indicators. Chapter 5 also examined the relevance of the pattern of MVPA accumulation (bouted or total) in regard to the associations tested.

Drawing from the Social-Cognitive Theory (SCT; Bandura, 1977, 2000) and the Ecological Framework of behaviour change (Sallis et al., 2006), Chapter 6 tested an integrated model of psychological (self-efficacy, SE) and environmental (facilities distance) predictors of accelerometer-assessed MVPA and in turn physical function (observed performance) and quality of life (physical, psychological).

Lastly and again following from the systematic review findings (Chapter 3), a qualitative inquiry on daily PA and sedentary experiences was carried out. The study examined how daily PA and SB are actualised, experienced and how they are linked to individuals' sense of well-being.

This Discussion Chapter summarises the findings from the Chapters capturing the main results of this thesis (3, 5, 6 and 7). Chapter 8 also highlights new perspectives and insights gained from the present work and discusses the implication of the findings, and their limitations, for future research, intervention development and public health.

Chapter 3: A systematic review of qualitative evidence on PA barriers and facilitators

The systematic review of 10 qualitative studies exploring PA barriers and facilitators in hip and knee OA revealed a complex interplay of physical, psychological, social and environmental factors that promote and hinder PA in this population. The findings were

deemed to fit nicely within the Biopsychosocial model of health. Regarding the physical domain, OA-related barriers, namely pain, functional limitations and mental distress (including feelings of depression), were most frequently reported and were common among all participants, whereas symptom management and maintaining mobility were reported as reasons for keeping active. In the intrapersonal/ psychological realm, knowledge of the benefits of exercise for OA and positive exercise experiences, determination to keep going despite OA (and making behavioural adjustments), psychosomatic well-being and PA enjoyment were PA facilitators. Viewing PA as potentially harmful or non-effective and not having positive PA experiences, lack of motivation and not prioritising PA over other life roles were PA barriers, frequently mentioned with reference to participation in exercise programs. In regard to the social domain, HCPs were perceived as having an influential role and could act as facilitators (mainly physiotherapists delivering exercise programs) or barriers (mainly doctors providing ambiguous or no information regarding PA in OA). The findings also revealed that support from important others and inspiration or demotivation by other group-members' performance were reported respectively as facilitators and barriers to engagement in exercise programs. References were scarce in regard to the relevance of the physical environment as a promoter or distractor from PA.

The systematic review applied rigorous methods at all stages. It also introduced a novel approach for quality assessment by combining the CASP tool and Lincoln and Guba's criteria of credibility, transferability, dependability, confirmability. This combination and the grading system (high, moderate, low quality evidence characterisation using CASP) adopted in the systematic review have been applied in subsequent systematic reviews of qualitative evidence, e.g., Rostami et al. (2018). All findings were grounded on high quality studies and were further supported by moderate quality studies.

The majority of the included studies in the systematic review presented in Chapter 3 were relevant to exercise interventions, which revealed a paucity of research on lifestyle PA. No studies on SB were identified, although relevant terms were included in the search. The systematic review findings informed the design of and questions addressed in the subsequent studies comprising the thesis. That is, (a) a quantitative study to assess barriers/ facilitators identified in the review and objective PA/ ST, which informed Chapters 5 and 6; (b) a qualitative study on lifestyle PA and sedentary experiences in the context of OA and well-being (Chapter 8).

Chapter 5: MVPA levels and correlates for different PA classification cut points

In Chapter 5, triaxial, age-relevant (Santos-Lozano et al., 2013; Aguilar-Farias et al., 2014) vs uniaxial, commonly applied in existing research (Troiano et al., 2008) cut points were compared. Findings revealed that choice of cut points for determining MVPA engagement might not have an effect on MVPA associations with disease-specific and well-being outcomes, depending on MVPA pattern (way of accumulation). In particular, the significant differences in time spent in PA intensities, ST and proportion of people meeting guidelines as a function of using two cut points, did not translate into differences in most of the associations examined, controlling for wear-time. More MVPA was associated with better physical function across MVPA patterns and cut points. More total (but not bouted) MVPA was associated with lower BMI, regardless of the cut points employed. More time spent in bouted MVPA was associated with better OA-related outcomes (pain, difficulties in daily activities), physical QoL and depressive symptoms regardless of cut points used. When comparing the direction and significance of MVPA-psychological variables correlations, there was a trend towards a more positive psychological profile for bouted than total MVPA. The findings presented in Chapter 5 suggest that age-relevant cut points employed in this study (Santos-Lozano et al, 2013;

Aguilar-Farias et al. 2014), calculate PA intensities/ ST which are more appropriate for people living with lower limb OA. MVPA cut points specifically, captured broader aspects of lifestyle PA than the ones that have been extensively used in lower limb OA (Troiano et al., 2008).

MVPA is not a homogenous behaviour. It incorporates and can be realised via various behavioural patterns, which were differentially associated with physical (OA-related) and psychological outcomes in people with hip and knee OA in the present study. Specifically, the findings revealed that bouts MVPA (as one distinct PA pattern) was more relevant to positive outcomes, even at levels much lower than that recommended (66 and 49 minutes per week) (DHHS, 2018).

Taken in their totality, Chapter 5 results imply that total MVPA and meeting/not meeting guidelines may not be sufficient or appropriate indicators of physical and mental outcomes in this population. MVPA represented MPA mainly (that is, time spent in VPA was minimal), which is in line with the research that supports the importance of moderate, but not vigorous, PA for joint preservation in OA (see Chapter 1). Given its relevance to health and well-being outcomes, bouts MPA could potentially be a specific target in the promotion of a physically active lifestyle in people living with lower limb OA.

Chapter 6: psychological and environmental predictors of MVPA, physical function and quality of life- an integrated model

The distinct pattern of bouts MVPA, based on age-relevant cut points (Santos-Lozano et al., 2013), was further supported by the analysis presented in chapter 6. In this chapter, a path model of MVPA predictors linking to physical function and quality of life was proposed and tested. Bouts, but not total, MVPA was found to be significantly linked to the PA predictors tested (selected on the basis of Chapter 3 findings, existing models of behaviour change and preliminary data analysis). Specifically, the proposed model of psychological (PA

Self-efficacy; SE) and environmental (facilities distance) predictors of MVPA, which in turn predicted physical function and QoL (physical, psychological), showed an acceptable/ good fit with the data for bouted MVPA only (and after the addition of a path from SE to psychological QoL). MVPA had a direct effect on physical function and indirect on physical QoL. Facility distance and SE also had indirect effects on physical function and physical QoL.

The value of these findings lies in support of a more integrated (and ecological) model, namely combining psychological and physical environmental variables. The results are also important as they supported PA predictors' link with a specific PA pattern (bouted MVPA) and associated well-being. Identifying a specific PA pattern, potentially more beneficial than others for quality of life outcomes in OA is important given the impact OA has on people's health and well-being and the call for addressing both in health-care (Rausch Osthoff et al., 2018). Second, current findings place physical environmental variables in the foreground along with psychological factors as relevant to PA promotion in hip and knee OA. A significant association between physical environment and MVPA has direct implications for urban planning as part of public health policies (WHO, 2017). It has been argued that changes in physical environments to facilitate positive health behaviours are required if we want such health behaviour changes on an individual level to be sustained (Sallis and Owen, 2015).

Thirdly, in regard to the findings presented in Chapter 6, SE emerges as a predictor not only of PA behaviour, but also of psychological quality of life. SE in the sense of experiencing causal agency is acknowledged as a basic human need in many theoretical frameworks (Gekas, 1989). SE as presented in Bandura's model (2000b) in particular, is a well-supported PA predictor (Jackson et al., 2014). Although not examining self-efficacy judgements specifically, a meta-analysis of 184 studies using SDT constructs found that the need for competence had the strongest correlation with mental health among all the variables tested (Ng et al., 2012).

The model proposed and tested in Chapter 6 incorporated two key predictors of PA in the literature (SE and neighbourhood facilities distance), rather than including a more extensive list of psychological and environmental variables. Although other cognitive-psychological PA predictors were assessed in the present research (such as autonomous motivation from Self-Determination theory (Ryan and Deci, 2000); outcome expectations from Social-Cognitive theory (SCT; Bandura, 1977)), these were not tested due to high skewness and ceiling effects. That is, on scales from one to five, 92% and 93.5% of participants scored three or above on Identified Motivation and Physical Outcome Expectations respectively, therefore variation was limited.

The findings reported in Chapter 6 should be interpreted with caution as data were cross-sectional and a full structural equation modelling (which would consider the measurement model/error in regard to the latent variables assessed) was not tested due to the limited sample size. Nevertheless, the present findings and their interpretation are consonant with current theoretical and empirical understanding of health behaviour (Bandura, 2000a; Sallis and Owen, 2015), as well as with qualitative findings reported in chapters 3 and 7.

Chapter 7: experiences of physical activity and sedentary behaviours in hip and knee osteoarthritis

In the qualitative study presented in Chapter 7, inductive thematic analysis of 12 interviews produced two overarching themes: PA Negotiations, including the themes *Valuing Mobility*, *The Burden of Osteoarthritis*, *Keep Going*, *The Feel-Good Factor* and Sedentary Behaviour Negotiations, including the themes *The Joy of Sitting*, *A Lot Is Too Bad*, *The Osteoarthritis Confines*. Two more themes, *The Life Context* and *Finding a Balance*, overlapped between the overarching themes. The findings reported in Chapter 7 revealed that PA and engagement in sedentary behaviours were multifaceted experiences, related to the

burden of OA, the need to keep mobile and keep enjoying life, and life circumstances. There was a dynamic relationship among these facets and a constant negotiation of their relative importance, which was reflected on overt PA/ sedentary behaviours. PA was impinged by OA, but was also a way of coping with OA and a means to experiencing enjoyment and living life to the fullest. Importantly, the findings suggested that PA choices were not made solely on the grounds of short term pain relief. People were consciously aiming at long-term preservation of mobility and living status. Engagement in sedentary activities was viewed as part of a desired way of life: selected activities were deemed enjoyable, although there was a consensus that too much sitting was harmful and signified a degradation of health and well-being. In terms of study participants' PA and ST behavioural regulation, a balance had to be constantly struck between short and long-term outcomes, limitations and mobility preservation/ enjoyment.

The findings confirmed, complemented and extended findings from previous chapters. For example, positive PA experiences and beliefs, mobility and symptom relief as a motivation for PA, which had emerged as important PA facilitators from exercise-focused studies in the systematic review (Chapter 3), recurred here with relevance to lifestyle PA habits. This is also in line with theoretical frameworks of behaviour change such as SCT (Chapter 6) and SDT. The lack of motivation for participation in exercise programs (Chapter 3) was discussed here in the context of life circumstances hindering PA (e.g., work and family commitments). The “life context” theme in particular, illustrates the broader influential role of the social environment, which can be elusive to fully capture in quantitative research (e.g., Chapter 6) and target in health-care interventions. The study also enabled insight into the physical-psychological interplay in people living with OA (Bartley et al., 2017; Hunt et al., 2008), which came up in chapters three, five and six. Physical and psychological aspects of PA and sedentary experiences in OA emerged as interwoven: OA limitations and distress, keep going literally

and metaphorically, experiencing physical benefits and a feel-good PA effect. Well-being was not just a mental state, it was brought up as an embodied experience in participants' narratives.

The qualitative study presented in Chapter 7 was the first to explore in-depth PA and sedentary experiences in the life context of individuals with lower limb OA and in relation to their sense of well-being. Methodological rigour was ensured through a number of processes, including reflexivity and external audit, the two processes that were identified as missing from existing relevant qualitative literature in chapter 3. The study went beyond viewing the OA experience as predominantly aversive and suggests that PA can be a self-management option consonant with individuals' personal values. Incorporating this perspective in PA promotion could be a promising approach. The findings also suggest that managing mental distress and keeping a positive attitude are important components of successful OA self-management and that acquiring positive PA experiences (effective in terms of managing symptoms, enjoyable) is a key factor in sustained PA engagement. It should be noted that the present findings stemmed from interviews with individuals who were physically active (based on personal narratives as well as accelerometer data) regardless of OA progression. This gives an insight of how the endpoint of PA promotion would look like with regard to internal processes and coping with external factors influencing PA and ST behaviour.

Novelty and insights

The present findings have added new perspectives and insights into the current body of understanding of PA in OA. Novel methodological approaches were employed. These included: appraisal of qualitative evidence (Chapter 3); comparison of PA/ sedentary time classification methods on the basis of their relevance to health and well-being (Chapter 5); integrating psychological (self-efficacy) and environmental (facility distance) variables in a path model predicting MVPA, physical function and quality of life and comparing the fit for

two different MVPA behavioural patterns- bouts and total MVPA (Chapter 6); in-depth exploration of PA and sedentary experiences in the context of living with OA and experiences of well-being (Chapter 7).

Within the research described in this thesis, new insights were gained with regard to accelerometer-assessed PA in OA. Specific PA behavioural patterns and their association with outcomes of interest might be more meaningful than just total PA calculation and characterisation of individuals as active/ inactive based on meeting the 150 minutes/ week target. Regarding total MVPA for example, cut points for PA classification made a difference with regard to associated OA-related and well-being outcomes, but not regarding physical function (walking performance). Bouts MVPA was identified as potentially more relevant to known PA predictors and quality of life, based on age-relevant cut points. To this author's knowledge, these types of comparisons are not well considered in the existing literature.

With regard to PA determinants in lower limb OA, the present work emphasises the potential of incorporating multilevel PA determinants in research and public health agenda. The role of psychological, social and physical environmental factors in PA engagement was supported, to various extents, across Chapters (3, 6 and 7). Regarding factors within the intrapersonal realm in particular, this thesis shed light on psychological/ cognitive PA determinants from the perspective of a population who on average appear to adopt a physically active lifestyle. Although, the full SCT and SDT models were not tested here, key constructs and tenets within these theoretical frameworks are relevant to the present findings. Specifically, quantitative data revealed that in this group autonomous motivation and outcome expectations were high on average, even without support from HCP and important others; the majority were engaging in PA habitually; higher PA SE was related to greater time spent on bouts MVPA and better psychological quality of life.

Based on the qualitative data (Chapters 3 and 7), the themes that emerged from the narratives of physically active participants highlighted the role of positive PA experiences, PA beliefs (and the interrelation between the two) and personal significance of symptom management and safeguarding mobility. These themes are directly and indirectly relevant to particular SCT concepts, namely, mastery experiences, SE and OE; also, to the SDT concepts of autonomous motivation (intrinsic and identified behavioural regulation), as well as basic psychological needs of competence and autonomy. The mental distress component which emerged in Chapters 3 and 7 is not directly discussed by the aforementioned theories, but autonomous motivation and basic psychological need satisfaction are considered predictors of well-being, whereas controlled motivation and need thwarting are linked to negative outcomes within SDT (Ryan and Deci, 2000). Also, existing evidence suggests that depression might be a risk factor for an inactive lifestyle (Roshanaei-Moghaddam et al., 2009). The distinction between a positive versus a resigned attitude when coping with OA that emerged in Chapter 3, the low levels of depressive and anxiety symptoms reported by the present study participants (Chapter 5) and the mentality and behaviour of a “keep going” perspective discussed in Chapter 7 are in line with the latter literature.

Chapter 7 also provided an understanding of SB in people with hip and knee OA. There were two sides to SB perceptions: on the one hand, engaging in sedentary activities was a positive experience (enjoyable activities, relaxation) and a necessity (need for rest). On the other hand, spending too much time sedentary was considered unpleasant and harmful. Besides these differential perceptions, SB was strongly linked to OA symptom management, which often dictated SB interruption. Most of the participants had come to this awareness based on their personal experience rather than guidance from their healthcare team. The present data shows that awareness and conscious effort can lead to a balance between sedentariness and PA,

enjoyment and disease management. Individuals enjoyed their sedentary time, but without disregarding the need to be active. This is reflected in their accelerometer data: although participants spent a lot of time engaged in SB, they also maintained a sufficient level of MVPA.

Limitations

Limitations relevant to each study were acknowledged in the respective chapters. Key limitations and their implications are further discussed in this section.

Sampling

Only 10%-20% of invited eligible participants from secondary care took part in the quantitative study. Similar proportions (9.2%) have been reported in a systematic review of PA interventions in adults over 55 years (Van Der Deijl et al., 2014). Bias in sampling is an acknowledged problem in PA research, as research volunteers are unlikely to be representative of the whole population which incorporates individuals inactive and disinterested towards PA (Baranowski et al., 1998; Ekkekakis and Brand, 2018). In the present study, eligible participants were informed that the study was focusing on PA in OA. Individuals who found PA inappropriate for their condition/ circumstances or did not engage in PAs may have been less inclined to participate in contrast to those more aware and positively predisposed. This is supported by the higher average MVPA levels (Chapter 5) in comparison to large-scale, cohort studies. Therefore generalisability of findings to the whole OA population, would be inappropriate. Nevertheless, the sample was representative of a wide range of participants according to age and OA severity. Also, all processes relevant to the study and data analysis have been reported in detail to ensure transparency (von Elm et al., 2014) and facilitate further utilisation of the present findings. In addition, the investigated PA determinants are consonant with theoretical frameworks formulated and tested on a wide variety of populations, therefore establishing their relevance to PA behaviour beyond differences pertinent to specific samples.

Confounding factors and sub-group analysis

With regard to the quantitative work, examination of confounding factors and sub-group analysis which would enable greater insight into the relationships tested, was not possible due to inadequate sample size. For example, analyses could be performed separately for hip and knee OA, younger/ older or retired/ non-retired age groups or on the basis of PA/ ST behaviour (e.g. time spent in bouts MVPA). The MVPA correlations tested in Chapter 5 accounted for wear-time only (i.e., MVPA as % of total wear time) and the model tested in Chapter 6 included only two MVPA predictors. Still, the selected analysis in Chapter 5 offered an easily comparable overview of associations across cut points and MVPA patterns. Also, main demographic PA correlates, namely gender and age, were included in model versions tested in Chapter 6.

One potential confounder, ST, which is an independent predictor of physical function in OA (Lee et al. 2015), was not studied quantitatively in the thesis, owing to the low accuracy of GT3X activity monitors in ST assessment when compared to direct observation and ActivPal accelerometers, especially regarding the distinction between and transitions from sitting to standing (Aguilar-Farías et al., 2014; Lyden et al., 2014; Lyden et al., 2012).

Implications for future research and promotion of an active lifestyle in hip and knee OA

Accelerometer-assessed PA

Inferences made in the existing literature about the link between MVPA and physical function are based on cut points that capture a higher intensity within the MVPA spectrum and examine MVPA as a single pattern (e.g., Dunlop et al., 2011; Song et al. 2017). Similarly, inferences made about the beneficial effects of LPA on physical function in lower limb OA based on stricter cut points (White et al. 2017), might be confounded by an overlap with MPA.

A study that compared low-LPA, high-LPA and MVPA in adults over 65 found that high-LPA, but not low-LPA and MVPA, was positively associated with well-being outcomes (Buman et al., 2010). Therefore, further exploration of bouted and non-bouted PA patterns in relation to OA-symptoms and quality of life will help identify optimal PA patterns and inform PA prescriptions and intervention targets. This applies to similar patient groups, e.g., other musculoskeletal conditions.

Multivariate and multilevel research of PA determinants

Larger samples are necessary to assess the relative contribution of various determinants of different PA and ST patterns and account for sub-group diversity. For example, following participation in a community-delivered exercise programme for arthritis (56% self-reported OA), physical function and self-efficacy for arthritis pain management improved for middle aged but not for older adults (Levy et al., 2012). Accounting for diversity in PA determinants within a population is also important. With regard to the common sense inference of the “feel-better” effect of PA, for example, Ekkekakis and Brand (2018) emphasised it should be considered conditional, since contrasting directionality (positive, negative and null) of the PA-affect relationship can be found within a given sample. The systematic review findings (Chapter 3) are consonant with the latter point. Although the present sample appeared to be positively predisposed towards PA based on both qualitative and quantitative data, examination of contrasting directionality for other known PA determinants could be possible through examining those relationships within subgroups on the bases of PA and OA characteristics. The phenotype classification by Knoop and colleagues (2011) could be a useful way of differentiating PA-related sub-groups. Based on multiple clinical characteristics (radiographic severity, lower limb muscle strength, BMI and depressive symptoms) the authors identified 5 distinct phenotypes: “minimal joint disease”, “strong muscle”, “non-obese and weak muscle”,

“obese and weak muscle” and “depressive”. They further discussed how these phenotypes could correspond to distinct PA profiles. The “minimal joint disease” phenotype appears to represent early OA. The strong muscle phenotype demonstrated levels of pain and physical function (self-reported and performance test) similar to the minimal joint disease phenotype, despite progressed radiographic findings found in 76% of the cases. This phenotype appears to correspond to a physically active (at present and in the past) subsample. It is likely that the “strong muscle” phenotype is more relevant to our sample. The two weak-muscle phenotypes could correspond to a predominantly sedentary, older group (+6 years than the average age of the other groups), where inactivity led to muscle weakness, with or without accompanying obesity. Both latter groups presented significantly worse pain and physical function in comparison to the minimal disease and strong muscle phenotypes. The “depressive phenotype” had clinical characteristics similar or worse (i.e., pain) than the obese and weak muscle phenotype (Knoop et al., 2011). A classification of this kind could enable the identification of key PA/ ST determinants among the different groups.

Physical environmental variables, acknowledged as PA determinants in the Ecological model of behaviour, have been overlooked in behavioural change interventions (Williamson et al., 2015). Clearly, changes in the physical environment, e.g., urban planning, are complicated and require large-scale, collaborative efforts and planning from central and local policymaking bodies. Although this level of influence is way beyond what could be brought about by most health research groups, accumulation of evidence on the relevance of environmental factors in PA promotion for a variety of contexts and diseases could have an impact on long-term population-level policies.

It could also be valuable to comparatively examine geographic areas of different socioeconomic status (SES). In this study participants were coming from UK areas with high

risk for poverty (Experian, 2012), although the vast majority did not report experiencing financial strain. A critique on PA and ST intervention studies has been that their effectiveness is not examined differentially by socioeconomic groups, despite existing evidence on disparities in PA/ ST in the general population (Hawkesworth et al., 2018). Decreased likelihood for lower limb OA incidence and pain for people of higher SES has also been reported (Kiadaliri et al., 2017). Such an effect makes multi-level interventions considering SES influences even more important in the promotion of active lifestyles.

Implications for health-care

Social factors related to HCPs although not addressed in the quantitative study, emerged in the qualitative work (Chapters 3 and 7). HCPs were viewed as having a key role in providing effective PA guidance/ prescription and helping patients overcome PA uncertainty and fears, a finding which is widely confirmed by the literature on lower limb OA (Hurley et al., 2018). Physiotherapy in particular was often discussed as the starting point of incorporating exercises in daily routine. However, in the absence of positive (perceived) input from HCPs, which was often the case, people were left in doubt about the utility and safety of PA for OA. A concerning finding from the quantitative data (not reported in the previous chapters) was that only 1/3 of the sample reported having some discussion about PA with their consultants and for this sub-sample, perceived psychological need support from consultant was negatively correlated with total MVPA [$r(34)=-.32$, $p=.06$, 95% CI= $-.64$, $-.02$]. Also, there was no significant difference in total ($t(95)=-.57$, $p=.57$) and bouted ($t(93)=1.60$, $p=.11$) MVPA between those who had discussed PA with their consultant and those who had not. Indeed, unfavourable HCPs' views have been reported, including uncertainty about the effectiveness of guidelines among GPs (Egerton et al., 2017) and physiotherapists (Holden et al., 2009), beliefs that PA adherence is the responsibility of the patient (Holden et al., 2009) or that patients are unwilling to adopt

lifestyle modifications (Zbehlik et al., 2016). Certain barriers are related to the health-care system itself, e.g., limited availability for treatment and follow-ups and funding (Holden et al., 2009; MacKay et al. 2017). These findings suggest that incorporation of PA promotion in health-care provision for hip and knee OA according to recommendations (NICE, 2014; Rausch Ostchoff et al. 2018) is not a straightforward process.

A single model of PA promotion will not be the optimal choice for all patients at all times (Nicolson et al., 2017). The findings in this thesis suggest that PA promotion and ST reduction in health-care should be a multicomponent intervention and address individual needs. At an individual-patient level, first, providing a sufficient knowledge-base regarding safety of PA patterns is essential. PA being counter to advice for certain OA subgroups, such as varus malalignment, or that overload can result in further structural changes and mobility limitations (which is in line with the common representation of OA as “wear and tear”), deem generic PA advice inappropriate. The importance of arthritis patients’ education has been acknowledged since the 1980s when the Arthritis Self-Management Program was developed by the Stanford Patient Education Research Center (Lorig and Holman, 1993) in US. The programme, which emphasised self-efficacy for arthritis symptom management and exercise, had beneficial effects on arthritis self-efficacy, exercise behaviour and health status and was later disseminated on a national basis through Arthritis Foundations in US, Australia and Canada (Lorig and Holman, 1993). Incorporating the reduction of SB as a behavioural change target appears to be feasible. Insights on SB from the present thesis suggest that raising awareness of the impact of prolonged ST and linking it to OA management could increase motivation for breaking up ST. Engagement of HCP in providing suggestions and planning on how to incorporate sedentary breaks in daily life could increase the opportunity to adopt this behaviour. Recent research in older populations and other arthritic populations suggest that introducing the concept of

breaking up sedentary time as part of a more active lifestyle can raise awareness (Greenwood-Hickman et al., 2016) and offer an achievable target (Gupta et al., 2018; Pinto et al., 2017). Current technological advancements enable the identification of a variety of behavioural patterns that are linked to better health status and can be promoted. Pervasive technologies (such as activity monitors in combination with tailored software) also constitute a promising intervention for raising awareness and setting optimal PA/ ST targets in arthritis (Gupta et al., 2018).

Second, facilitating positive personal PA experiences, that is beneficial for OA and pleasurable, is key in PA promotion. Such experiences besides being inherently rewarding, can further reinforce positive PA beliefs (therefore autonomous motivation/ outcome expectations) and PA SE. Sedentary behaviours appear to be inherently pleasurable (up to an extent), but ST reduction can be linked to symptom management (Chapter 7). Targeted behaviours can also be linked to personal values, such as long term preservation of mobility and quality of life.

Third, it is known that for established behavioural patterns, past behaviour is a strong predictor (Elavsky et al., 2005; Triandis, 1980). Established inactivity habits, such as those related to the “weak muscle” phenotypes by Knoop et al. (2011), cannot be expected to change with short-term interventions. Booster sessions and follow-ups spread over long periods are needed. Alternatively, a PA promotion intervention at early stages of OA is timely as it could facilitate long-term PA adoption. In addition, specialised psychological support should be available for selected subgroups, e.g., those with high levels of depression as well as younger patients. Overall, specific messages regarding PA patterns (e.g., bouts or total MVPA, muscle-strengthening exercises) and how to effectively convey them to patients in the health-care context require further clarification.

Conclusion

This thesis has applied a comprehensive combination of rigorous and novel research methods to deepen the current understanding of PA behaviours and their determinants in people living with hip and knee OA. Theoretical frameworks of health behaviour were employed in an open, dialectic manner, allowing for inductive data interpretation and a spectrum of theoretical constructs to be tested, rather than applying a pre-defined model. This approach enabled the understanding of PA behaviours in OA from the individual's perspective in a broader life context, which inevitably operates at many levels, from individual to socio-environmental. In a complementary manner quantitative and qualitative data told the story of the complex and multifaceted phenomenon of PA and to a lesser extent ST in hip and knee OA.

PA behaviour is dynamic and reflects the interplay among various factors. Therefore, from a behavioural change perspective, it can be targeted at many levels: individual (physical, psychological), social and environmental. The findings highlighted the interplay between physical (pain, physical function/ mobility) and psychological factors (beliefs, SE, motivation, well-being) related to PA, but also the strong influences of the social (HCPs, work and family commitments) and physical environment. Qualitative data offered an insight on a wide array of cognitive and social-environmental determinants; quantitative data specified PA patterns, confirmed their link to better physical and well-being outcomes, confirmed the relevance of SE to PA/ quality of life and brought physical environment in the foreground. The link of PA (as exercise participation, objectively measured MVPA or personal accounts of an active lifestyle) with physical health and well-being was evident across studies.

While study participants engaged in a satisfactory amount of MVPA, they were also spending a significant proportion of their waking hours in SB. Qualitative data revealed that SB was also the outcome of an interplay among various types of factors. Leisure sedentary

activities were pleasurable and meaningful, and therefore positively reinforcing (Epstein, 1998). However, there was also an awareness that “too much sitting” is potentially harmful for health and ST was less for those who perceived it as a waste of time and indication of poor life quality. In addition, interruption of prolonged sitting was “facilitated” by efforts to manage OA symptoms. These latter two points, i.e., reduction of prolonged ST for health and OA management, could be utilised in behavioural change interventions. Sedentary time interruption can be a much more achievable target than increase in bouts of MVPA for example, and also applicable to physical environments with limited potential for change, e.g., sedentary work environments.

Autonomy, independence and quality of life are recognised as key outcomes in the aging population (WHO, 2017). Similarly the Arthritis Research UK report (2013) emphasised that both physical health and well-being need to be addressed as part of the OA health-care provision. Overall, the present work provided evidence on the utility of a physically active lifestyle as a means of OA management and enhancing quality of life in individuals with hip and knee OA. Promotion of an active lifestyle needs to be multilevel. At an individual level, PA promotion could include short daily MPA bouts in the agenda and designing interventions that provide positive PA experiences. PA/ ST behaviour change could be further supported through the healthcare system by targeting cognitive and motivational factors. Incorporation of active lifestyle promotion in OA treatment at all levels and reinforcement of HCPs’ engagement with it could be key steps towards this direction. But community-wide interventions can be influential as well and the options are vast. Next steps in this research field would be the assessment of social and physical environmental factors along with psychological; also, large scale, longitudinal studies designed to reach more representative samples, especially those we tend to miss. In the end behaviour change can start from the individual as much as from public

health organisations. Small changes at all levels add up and gradually accumulate into big transformations.

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Appendix 1

Appraisal of methodological quality of Stubbs et al. (2014) using AMSTAR

AMSTAR Item	Assessment outcome (Stubbs et al., 2014)
1. A priory study design provided	Yes
2. Duplicate study selection and data extraction	Yes
3. Comprehensive literature search	Yes
4. Publication status and inclusion	Yes
5. List of studies (included, excluded)	Yes
6. Study characteristics provided	Yes
7. Study quality assessed and reported	Yes
8. Study quality used in formulating conclusions	Can't answer
9. Methods to combine findings appropriate	Can't answer
10. Publication bias assessed	Yes
11. Conflict of interest included	Yes

Appendix 2

2.1 PRISMA Checklist

Section/topic	#	Checklist item	Reported on thesis page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	43
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	43
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	47-48
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	48
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	48
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	48-49

Section/topic	#	Checklist item	Reported on thesis page #
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	49
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	49
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	50
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	50
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	50
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	n/a, 2.8 Quality appraisal is reported as relevant to a qualitative SR #4
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a, 2.9 Phenomenon of interest is stated as relevant to a qualitative SR #4
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	51

Section/topic	#	Checklist item	Reported on thesis page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	n/a, further details are reported under section Amendments to the SR protocol #11
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	51
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	52
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	53
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome-level assessment (see Item 12).	n/a, 3.3 Study appraisal is reported, #5
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot.	54-56
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	60-67
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a

Section/topic	#	Checklist item	Reported on thesis page #
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., health care providers, users, and policy makers).	67-68, 72
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review level (e.g., incomplete retrieval of identified research, reporting bias).	71
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	70
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	73

2.2 Systematic review draft search on MEDLINE- Ovid interface

1	osteoarthritis.mp. or exp Osteoarthritis, Hip/ or exp Osteoarthritis/ or exp Osteoarthritis, Knee/
2	(osteoarthriti* or osteo-arthriti* or osteoarthrotic or osteoarthros*).ti,ab.
3	(coxarthrosis or gonarthrosis).ti,ab.
4	"knee pain".mp.
5	"hip pain".mp.
6	"lower limb".mp.
7	exp Lower Extremity/ or "lower extremit*".mp.
8	(degenerative adj2 arthritis).ti,ab.
9	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10	physical activity.mp. or exp Motor Activity/
11	exp Exercise/ or exp Exercise Therapy/ or exercise.mp.
12	exp Sports/ or sports.mp.
13	exp Life Style/ or exp Sedentary Lifestyle/ or sedentary.mp.
14	"non-exercis*".ti,ab.
15	"activities of daily living".mp. or exp "Activities of Daily Living"/
16	10 or 11 or 12 or 13 or 14 or 15
17	(maintain* or maintenance or support* or ongoing or "on-going" or adherence or reinforce* or comply* or compliance or "long-term" or adoption or engagement or avoidance or boost* or refresh* or remind* or promotion or promot* or "physical activity uptake" or "behavio* change" or "lifestyle change").ti,ab.
18	(barrier* or impediment or limit* or facilitator* or enablers or enabl* or motivators or motivat* or influenc* or factors or determinants).ti,ab.
19	facilitator*.mp.
20	barrier*.mp.
21	adherence.mp.
22	exp Motivation/ or motivators.mp.
23	social support.mp. or exp Social Support/
24	17 or 18 or 19 or 20 or 21 or 22 or 23
25	exp Qualitative Research/ or qualitative.mp.
26	(interview* or theme* or experience).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
27	("content analysis" or "grounded theory" or "thematic analysis" or "phenomenological analysis" or phenomenolog* or narrative* or discourse or ethnograph*).ti,ab.
28	((("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide) adj3 (interview* or discussion* or questionnaire*)).ti,ab.
29	(focus group* or interview* or fieldwork or "field work" or triangulation or "data saturation" or "key informant").ti,ab.
30	25 or 26 or 27 or 28 or 29
31	9 and 16 and 24 and 30

2.3 Study selection eligibility criteria

Title:.....		
Author(s) and date:		
<i>Study should be deemed eligible if responses to all items are under the “yes” column.</i>		
	Yes	No
1. Qualitative study design or mixed methods design.		
2. Participants are adults with a physician’s diagnosis of hip or knee osteoarthritis, regardless of radiographic evidence. If the study sample also involves groups of patients with other types of arthritis, then the group with the highest proportion of patients should be that of knee and/ or hip OA.		
3. (a) The study directly (i.e. it is stated so in the study aims or, relevant interview questions are included) explores the factors/ barriers/ enablers/motivation that correspond to engagement/ adoption/ maintenance of PA/ exercise. Or (b) the study directly addresses or focuses on any aspect of the experience or perceptions of people living with hip or knee OA regarding PA and/ or exercise.		
4. Participants have not undergone and are not about to undergo hip or knee arthroplasty.		
5. Written in English.		

2.4 Lincoln and Guba's criteria for qualitative study appraisal

<p>Criteria for trustworthiness based on Creswell (2007) and Cohen and Crabtree (2006).</p> <p>Title:</p> <p>Author(s) and date:</p> <p>Study No:</p>	<p>Reviewer's assessment (Technique applied? How?)</p>
<p>Credibility</p>	
<p>Prolonged engagement and persistent observation. Do the researchers spend sufficient time in the field, observe, talk to different people, build relationships, check for misinformation stemming from the researcher or the informants?</p>	
<p>Triangulation. Do the researchers make use of multiple data sources, investigators, theories to enhance understanding and ensure a rich and robust account of the study inquiry?</p>	
<p>Peer review or debriefing. "External check of the research process" (Creswell, 2007; p.208) or exposition of the research process to an unaffected peer. Do sessions between the researcher and a peer take place? Are written accounts of these sessions being kept?</p>	
<p>Negative case analysis. Do the researchers take account of the data that do not fit with emerging patterns or explanations? Do they revise the initial hypotheses and analysis until it accounts for the majority of cases?</p>	
<p>Referential adequacy. "Identifying a portion of data to be archived, but not analysed. The researcher then conducts the data analysis on the remaining data and develops preliminary findings. The researcher then returns to this archived data and analyses it as a way to test the validity of his or her findings" (Cohen and Crabtree, 2006).</p>	
<p>Member checking. Do the researchers take data, analyses, interpretations, conclusions back to the participants to evaluate the truthfulness of the account?</p>	

Transferability	
Thick description refers to “describing and interpreting observed social action (or behaviour) within its particular context” (Ponterotto, 2006) Does the author achieve to give a sense of verisimilitude? Does the author describe in detail each part of the study (fully describing the study participants; settings and procedures, such as location and length of the interviews, recording procedures, interviewer’s and interviewee’s reactions; results, e.g. long quotes from the participants or the interview dialogue; successfully bringing together the participants’ experiences with the researchers’ interpretation of those in discussion)?	
Dependability	
External audit (“inquiry audit”) Is there an “external consultant”, who is not part of the study, examining the process and product of the study?	
Confirmability	
External audit (“confirmability audit”)	
Reflexivity (clarification of researcher bias). Are the authors reflexive, i.e. do they “identify the perspectives they bring to their studies as insiders and/ or outsiders” and ways through which those affect “how they analyse, interpret and report the findings” (Sparkes and Smith, 2014: p 181-3). Is there a “critical friend” to help in this process?	
Triangulation	
Audit trail. Is the process of the study transparent and trackable? Do the researchers provide descriptions of the decision making process in detail?	

Appendix 3

3.1 Findings: themes and supporting references.

1. Physical health

Barriers (#studies, #references)	References	Facilitators (#studies, #references)	References
Physical barriers and limitations (9, 94)	<p><i>While pain was not attributed to their participation in the intervention the pain was described as having a major impact on their perceived opportunity to be physically active at present. (Hammer, 2015)</i></p> <p><i>All participants discussed experiencing intense physical pain on a daily basis, and how it negatively affected their desire to be active... In addition to these limitations, participants spoke of fatiguing rapidly, which made considering physical activity as more of a challenge (Stone and Baker, 2015)</i></p> <p><i>Stiffness and fatigue were barriers to exercising. "It was like my body was made of lead" (Petursdottir, 2010)</i></p> <p><i>Two participants, who were both hikers, reported limiting effects of OA knee pain... A</i></p>	<p>PA for mobility, symptom relief and health (9, 34)</p>	<p><i>Some informants even expressed how their PA maintenance was partly motivated by the belief that PA could help them to postpone or maybe avoid surgery (Hammer et al., 2015).</i></p> <p><i>"The main motivation to do all this is to prevent an operation to get a new hip" (participant with long-term goal) (Veenhof et al., 2006)</i></p> <p><i>"I realised my mobility would get worse if I didn't do something about it so I started exercising". (2, 3, 20, 25) (Hendry et al., 2006)</i></p> <p><i>"I feel like the Tin Man- that if I stop moving, I'll rust up and that will be it" (Kaptein et al., 2013)</i></p> <p><i>As with the pain, however, the experience of less stiffness and more stamina turned out to be facilitating. (Petursdottir et al., 2010)</i></p>

	<p><i>grandmother shared fears and concerns regarding dropping or falling on her grandchildren due to both hand and knee pain. (Kabel, 2014)</i></p> <p><i>'But as soon as someone says 'let's go for a walk....' It's the last thing I want to do because it hurts too much ...' (Kaptein, 2013)</i></p> <p><i>'...the day after I just couldn't cope, I was in so much pain' (Fisken, 2015)</i></p> <p><i>'Exercise hurts. The pain was almost unbearable but I still carried on. Yes, it was very strenuous, but that's how it is, the pain becomes increasingly worse, I think...it just becomes more and more painful.' (Thorstenson, 2006)</i></p> <p><i>Vi, Hilary, Ethel and Eileen all mentioned their being overweight as contributing to their knee symptom. (Campbell, 2001)</i></p> <p><i>Ability was also limited by a perceived general lack of physical fitness, sometimes attributed to old age. (Hendry, 2006)</i></p>		<p><i>"The physiotherapist professionally guided me to feel less pain. It made me want to do exercises on my own." (Stone and Baker et al., 2015)</i></p> <p><i>The perceived severity of knee symptoms was an important factor in motivation, with those experiencing severe pain and/or loss of mobility being most likely to continue to exercise. (Campbell et al., 2001)</i></p> <p><i>...hip pain was highlighted as a common symptom, and several informants linked a perceived reduction in pain to their increased PA level, which represented an important incentive to maintain PA post-intervention. (Hammer et al., 2015)</i></p> <p><i>"Well, it is different now because, as I've already said, previously you exercised to maintain your level of fitness whereas now you exercise in order to regain your physical condition..." (Thorstenson et al., 2006)</i></p> <p><i>"Strengthening your muscles..keeping your weight down...keeps you in shape" (Fisken et al., 2015)</i></p> <p><i>Disconfirming case: Some participants who scored high on the Patient Global Assessment (eg, because they perceived less pain) did not continue with their activities, while some participants who scored low on the Patient Global Assessment (eg, because their pain remained the same) reported that their level of activities had increased considerably. (Veenhof et al., 2006)</i></p>
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2. Intrapersonal factors: themes and references.

Major theme	Barriers (#studies, #references)	References	Faci/tors (#studies, #referenc es)	References
Experience and beliefs about PA and OA	PA as non-effective, harmful or of doubtful effectiveness (6, 36)	<p><i>Experiencing pain while exercising made it difficult to decide whether it was beneficial or counterproductive.</i> (Thorstenson, 2006)</p> <p><i>[Counter-advice or no recommendations] created further confusion about physical activity and the potential benefits for osteoarthritis.</i> (Stone and Baker, 2015)</p> <p><i>Many participants were worried that exercise was wearing out their joints...</i> (Hendry, 2006)</p> <p><i>...many participants [were] uncertain whether PA was good or bad for them when they have arthritis.</i> (Kaptein, 2013).</p> <p><i>If, however, the benefits of the physiotherapy were not perceived as sufficient...non-compliance was a rational outcome...</i> (Campbell, 2001)</p>	PA as beneficial (7, 60)	<p><i>They continued to undertake exercises... from which they perceived they would derive the most benefit.</i> (Campbell, 2001)</p> <p><i>"Keeps the body moving, takes your mind off it, it's good to be outside. Yea, keeping active, or else if you've got osteo, it can get you right down..."</i> (Fisken, 2015)</p> <p><i>[Among maintainers] it was generally described how PA, in addition to the physical effect, also significantly contributed to their psychological well-being.</i> (Hammer, 2015)</p> <p><i>They [maintainers] were more likely to have noticed beneficial effects on their OA knee, or general health and well-being as a result of exercise.</i> (Hendry, 2006)</p> <p><i>Other participants were motivated by the results of the exercise, not because they liked it or enjoyed it.</i> (Petursdottir, 2010)</p>

	OA beliefs (5, 17)	<p><i>The two informants who had not managed to maintain an increased level of PA expressed how they had hoped for an improvement in their hip specific symptoms, which none of them had achieved. (Hammer, 2015)</i></p> <p><i>“There’s no cure, only pain relief” (Hendry, 2006)</i></p> <p><i>“There is nothing that can be done about OA; therefore, I do nothing” (Petursdottir, 2010)</i></p> <p><i>“...exercise can help, I am convinced about that, although it did not work for me...If one had started to exercise five or six years earlier, it might have helped.” (Thorstenson, 2006)</i></p> <p><i>Another said, “... if you're a very active person, especially professional athletes ... they basically tell you you'll have arthritis when you get older.” (Kaptein, 2013)</i></p> <p><i>“I was having trouble with my knees every so often it did hurt you know with one thing and another. Working in the construction</i></p>	<p><i>Knowledge about PA</i> (4, 15)</p>	<p><i>The informants expressed satisfaction and were convinced of the effectiveness of exercise. (Thorstenson, 2006)</i></p> <p><i>“I really know these exercises have beneficial effects and that motivates me to continue with my exercises” (Veenhof, 2006)</i></p> <p><i>It was described how increased knowledge and information about PA had led to an increased awareness of exercising and of doing this at a certain intensity and frequency... (Hammer, 2015)</i></p> <p><i>Most of the participants had experienced being educated by their physical therapists. (Petursdottir 2010)</i></p> <p><i>..many [participants] were unaware of specific osteoarthritis-related benefits and unsure of what activities would provide optimal self-management. (Stone and Baker, 2015)</i></p> <p><i>Overall, most informants understood and acknowledged, but many undertook only a limited programme of exercise. (Campbell, 2002)</i></p> <p><i>[To experience coherence] This conception contained statements about connecting knowledge about osteoarthritis with knowledge and experiences of exercise. (Thorstenson, 2006)</i></p>
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		<p><i>industry there is a lot of lifting and a lot kneeling you see and I felt well I wonder if that's got anything to do with it."</i> (Campbell, 2001)</p>		<p>Disconfirming case: <i>"You are in a vicious circle where you become less and less active, and the bones are grinding more and more due to muscle weakness. I could see that and I could understand it, but the knowledge has not helped me"</i> (Hammer, 2015)</p>
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	<p><i>the other described feeling a lack of motivation towards PA. (Hammer, 2015)</i></p> <p><i>[Reasons for not finding time to exercise...] others freely admitted to being lazy or lacking motivation. (Hendry, 2006)</i></p> <p><i>One of the participants seemed to lack the motivation to exercise, based on an overwhelming experience of boredom while exercising. She declared that she would never, ever exercise, no matter what. "It is dead boring, so I just don't do it and never will" (Petursdottir, 2010)</i></p> <p><i>"You need to have the will to do it... when you are well you don't do it, and when you need to do it, then it hurts and therefore you don't do it (laughter)." (Thorstenson, 2006)</i></p> <p><i>...all non-adherent participants reported a short-term initial goal or had no specific goal. (Veenhof, 2006)</i></p> <p><i>Those who ceased exercising often cited conflict with regular routines to explain why continuing with exercises was not possible. (Campbell, 2001)</i></p>	<p><i>Adjustments, prioritization and personal effort (9, 41)</i></p>	<p><i>Occasionally participants mentioned adding new activities to their lives: "I learned how to ski about eight years ago. I always wanted to do it and I thought I'm not going to let this get me down" (Kaptein, 2013)</i></p> <p><i>The majority of informants described how they regularly adjusted their exercises and intensity in an attempt to strike a balance between continuously increasing intensity while at the same time considering the experienced pain. (Hammer, 2015)</i></p> <p><i>They were eager to find activities and exercise that fitted them and, in many cases, adapted their exercises to their life with OA. (Petursdottir, 2010).</i></p> <p><i>'My knees were getting really bad and I, so thought, well the only thing I can do really is to do aqua, which I did and I love it' (Fisken, 2015).</i></p> <p><i>Prioritising exercise and making it part of a weekly routine helped some people to maintain their exercise habit. "... I try and say, OK well I'll go there [gym], have a shower and go shopping... I try to fit it in." (Hendry, 2006)</i></p> <p><i>More important [in increasing motivation] was the willingness and ability to accommodate the exercises into everyday life. (Campbell, 2001)</i></p>
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		<p><i>For others finding time to exercise was a low priority... “when I’m busy I forget.” (Hendry 2006)</i></p> <p><i>Despite recognising the importance of PA, it was considered optional or discretionary compared to essential roles such as work and family.(Kaptein, 2013)</i></p> <p><i>“One is so occupied that it is very easy not to find time for exercise. Everything else takes precedence.” (Thorstenson, 2006)</i></p>		<p><i>“I continue with my exercises, they are integrated in my daily living.” (Veenhof, 2006)</i></p> <p><i>In order to deal with limited time and energy, many participants made tradeoffs. I've had to choose ... where I put my energy, and I know that some days I feel that all I've done is work, so that's kind of a bummer” (Kaptein, 2013)</i></p> <p><i>He engaged in modified activity, not playing as aggressively as he wanted to, to avoid pain but did not opt out of the activity completely. (Kabel, 2014)</i></p> <p><i>“Well I suppose to some extent it is up to yourself how much effort you wish to put into it, ... if I don’t want to do anything then I don’t think I ll benefit from any treatment. I suppose that at the end of the day the outcome of the treatment depends on no one but myself” (Thorstenson, 2006)</i></p> <p><i>Disconfirming case: Later in their interviews both went on to admit some personal responsibility for their lack of compliance... “It's just excuses when it comes down to basics. I mean you know you could get up in the morning and do it between 6 or 7 or something like that.” (Cambpell, 2001)</i></p>
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Emotions	OA-related distress (6, 23)	<p><i>6 of the 10 participants self-identified as having some type of embarrassment-related experience, usually general embarrassment and frustration over their physical limitations due to the OA pain. (Kabel, 2014)</i></p> <p><i>Participants expressed depressing thoughts, referring to osteoarthritis as “mentally agonizing”. (Stone and Baker, 2015)</i></p> <p><i>“I don’t know if you can imagine how it is to be confronted with things that you want to do but you are unable to. That is mentally stressful.” (Hammer, 2015)</i></p> <p><i>A few of the women mentioned ‘paralyzing fatigue’ as a major barrier for getting anything done and felt it might be related more to mental fatigue... (Petursdottir, 2010)</i></p> <p><i>A few individuals noted a loss of their identity as an athletic or physically active person... they often tried to hide difficulties with activities from others. (Kaptein, 2013)</i></p> <p><i>“It got worse and worse and I started falling down ... it's so embarrassing.” (Campbell, 2001)</i></p>	Enjoyment (4, 22)	<p><i>Not surprisingly, people who enjoyed exercising were likely to continue; those that disliked it stopped. “I really do enjoy the gym; I look forward to going.” (Hendry, 2006)</i></p> <p><i>Some participants based their motivation on the fact that they liked PA and therefore had been physically active. “I have always enjoyed physical activity” (Petursdottir, 2010)</i></p> <p><i>“The buoyancy...I like deep water...It takes the impact off your joints...it gives you freedom...if you’ve been sedentary and not able to move around...the water makes you feel wonderful” (Fisken, 2015).</i></p> <p><i>“I feel such a fool standing on one leg and going up and down on my own and I tends to drop it I do.” [non-maintainer] (Campbell, 2001)</i></p>
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3a. Social Environment: themes and references.

Major theme	Barriers (#studies, #references)	References	Facilitators (#studies, #references)	References
Health professionals	Lack of support from health professionals (5, 22)	<p><i>Sometimes the advice was vague or absent... Occasionally exercise was discouraged.</i> (Hendry et al., 2006)</p> <p><i>“So I go to the doctor and all he just simply done was put his hand on my knee, he said ‘move your leg,...you are getting old, you’ve got rheumatism.’”</i></p> <p>(Campbell et al., 2001)</p> <p><i>...physicians often provided them with counter advice or did not offer any recommendations...</i></p> <p>(Stone and Baker, 2015)</p> <p><i>“They have not done it [encouraged exercising]”</i> (Petursdottir et al., 2010)</p> <p><i>“The instructor was not geared up for my particular disability [OA]... and I found it very stressful”</i></p>	Support from health professionals (8, 50)	<p><i>Advice from health professionals was mainly in favour of exercise and consisted of encouragement to exercise, advice about specific exercises, and referral to a gym.</i> (Hendry et al., 2006)</p> <p><i>The supervision by physical therapists highly influenced the informants’ ability to progress in training intensity as the physical therapists verbally expressed their confidence in the participants and exhibited realistic expectations about their exercise abilities</i> (Hammer et al., 2015)</p> <p><i>All participants spoke about the instrumental role of health care providers in influencing and encouraging physical activity.</i> (Stone and Baker, 2015)</p> <p><i>“Well, I always say that my physical therapist is as good as any psychologist.”</i> (Petursdottir et al., 2010)</p> <p><i>Overall, most informants understood and acknowledged, as they were instructed by the physiotherapist, that they should do the exercises often</i></p>

		(Fisken et al., 2015)		<p><i>and regularly, but many undertook only a limited programme of exercise. (Campbell et al., 2001)</i></p> <p><i>It appeared that all adherent participants reported that... the physiotherapists had a coaching role during intervention. (Veenhof et al., 2006)</i></p> <p><i>"I think that [an instructor] is good because then you learn what to do so that you do not do it in the wrong way." (Thorstenson et al., 2006)</i></p> <p><i>"...knowing that aqua is for people possibly who have arthritis...they ought to have.. an extra training course or something to fit, to accommodate that" (Fisken et al., 2015)</i></p>
Social support	Social comparison as demotivating (5, 15)	<p><i>Comparison with others with more limiting disease or a stoic attitude to knee symptoms all seemed to be associated with an attenuation of the motivation to comply" (Campbell et al., 2001)</i></p> <p><i>"I found it very stressful to be honest because I felt like I had to do the same as the others and keep up..."(Fisken et al., 2015).</i></p> <p><i>"They don't want to be dragged down by somebody that's not up to their standard I would think." (Hendry et al., 2006)</i></p>	Social support facilitating PA (7, 43)	<p><i>The majority of informants described how they continued to exercise with others because of the mutual support and encouragement they hereby achieved... (Hammer, 2015)</i></p> <p><i>The support, caring, and encouragement of others were among important external factors influencing how much the participants exercised. (Petursdottir, 2010)</i></p> <p><i>"I think it's important to be with other people, how other people cope and that you're not alone and there are other people you know, in similar situations." (Fisken, 2015).</i></p>

		<p><i>"I couldn't keep up with everyone else and felt like I was dragging them behind."</i> (Kabel et al., 2014)</p> <p>Disconfirming case: <i>Participants also gave examples of persisting with a painful activity and risking intensifying the pain because of social pressure or the desire to avoid embarrassment and disapproval...</i> (Kabel et al., 2014).</p>		<p><i>"I like the gym referral scheme because you're in a group of people who all have problems."</i> (Hendry, 2006)</p> <p><i>Eileen explained how difficult it was to continue the exercises programme since she stopped seeing the physiotherapist.</i> (Campbell, 2001)</p> <p><i>An important facilitator of PA and a strategy that helped some participants 'stay in the game' was having social support...</i> (Kaptein, 2013)</p> <p><i>"One of my friends who knows about my arthritis asked me if I ever exercise...Then she said she would work out with me if I wanted to. That was the first time I ever seriously thought about exercising.</i> (Stone and Baker, 2015)</p>
	Lack of social support (4, 8)	<p>[Sedentary informants] <i>had been given scant encouragement to exercise.</i> (Hendry et al., 2006) [Regarding family's attitudes] <i>some of the women expressed having a hard time justifying to themselves and their families their need to spend time exercising.</i> (Petursdottir et al., 2010).</p> <p><i>Not only [about half of the participants] did not receive support from others to manage physically demanding activities at work, they often tried to hide difficulties with activities from others.</i> (Kaptein et al., 2013)</p>		

		<p><i>“If perhaps my wife would work with me and you had a bit of competition...”</i></p> <p>(Campbell et al., 2001)</p>		
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Appendix 4

4.1 Ethics letters of approval

Miss Maria Archontissa Kanavaki
School of Sport, Exercise and Rehabilitation Sciences
University of Birmingham
Birmingham
B15 2TT

Email: hra.approval@nhs.net

27 September 2016

Dear Miss Kanavaki

Letter of HRA Approval

Study title:	Correlates of sedentary behaviour and physical activity in Rheumatoid Arthritis (RA) and Osteoarthritis (OA)
IRAS project ID:	198880
REC reference:	16/WM/0371
Sponsor	University of Birmingham

I am pleased to confirm that **HRA Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications noted in this letter.

Participation of NHS Organisations in England

The sponsor should now provide a copy of this letter to all participating NHS organisations in England.

Appendix B provides important information for sponsors and participating NHS organisations in England for arranging and confirming capacity and capability. **Please read *Appendix B* carefully**, in particular the following sections:

- *Participating NHS organisations in England* – this clarifies the types of participating organisations in the study and whether or not all organisations will be undertaking the same activities
- *Confirmation of capacity and capability* - this confirms whether or not each type of participating NHS organisation in England is expected to give formal confirmation of capacity and capability. Where formal confirmation is not expected, the section also provides details on the time limit given to participating organisations to opt out of the study, or request additional time, before their participation is assumed.
- *Allocation of responsibilities and rights are agreed and documented (4.1 of HRA assessment criteria)* - this provides detail on the form of agreement to be used in the study to confirm capacity and capability, where applicable.

Further information on funding, HR processes, and compliance with HRA criteria and standards is also provided.

It is critical that you involve both the research management function (e.g. R&D office) supporting each organisation and the local research team (where there is one) in setting up your study. Contact details and further information about working with the research management function for each organisation can be accessed from www.hra.nhs.uk/hra-approval.

Appendices

The HRA Approval letter contains the following appendices:

- A – List of documents reviewed during HRA assessment
- B – Summary of HRA assessment

After HRA Approval

The document “*After Ethical Review – guidance for sponsors and investigators*”, issued with your REC favourable opinion, gives detailed guidance on reporting expectations for studies, including:

- Registration of research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics, and is updated in the light of changes in reporting expectations or procedures.

In addition to the guidance in the above, please note the following:

- HRA Approval applies for the duration of your REC favourable opinion, unless otherwise notified in writing by the HRA.
- ☐ Substantial amendments should be submitted directly to the Research Ethics Committee, as detailed in the *After Ethical Review* document. Non-substantial amendments should be submitted for review by the HRA using the form provided on the [HRA website](http://www.hra.nhs.uk), and emailed to hra.amendments@nhs.net.
- ☐ The HRA will categorise amendments (substantial and non-substantial) and issue confirmation of continued HRA Approval. Further details can be found on the [HRA website](http://www.hra.nhs.uk).

Scope

HRA Approval provides an approval for research involving patients or staff in NHS organisations in England.

If your study involves NHS organisations in other countries in the UK, please contact the relevant national coordinating functions for support and advice. Further information can be found at <http://www.hra.nhs.uk/resources/applying-for-reviews/nhs-hsc-rd-review/>.

If there are participating non-NHS organisations, local agreement should be obtained in accordance with the procedures of the local participating non-NHS organisation.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application

procedure. If you wish to make your views known please email the HRA at hra.approval@nhs.net. Additionally, one of our staff would be happy to call and discuss your experience of HRA Approval.

HRA Training

We are pleased to welcome researchers and research management staff at our training days – see details at <http://www.hra.nhs.uk/hra-training/>

Your IRAS project ID is **198880**. Please quote this on all correspondence.

Yours sincerely

Natalie Wilson
Assessor

West Midlands - Black Country Research Ethics Committee

The Old Chapel
Royal Standard Place
Nottingham
NG1 6FS

Please note: This is the favourable opinion of the REC only and does not allow the amendment to be implemented at NHS sites in England until the outcome of the HRA assessment has been confirmed.

25 September 2018

Miss Maria Archontissa Kanavaki
School of Sport, Exercise and Rehabilitation Sciences (PGRs' pigeon hole)
University of Birmingham
Birmingham
B15 2TT

Dear Miss Kanavaki

Study title:	Correlates of sedentary behaviour and physical activity in Rheumatoid Arthritis (RA) and Osteoarthritis (OA)
REC reference:	16/WM/0371
Amendment number:	3
Amendment date:	13 September 2018
IRAS project ID:	198880

The above amendment was reviewed on 21 September 2018 by the Sub-Committee in correspondence.

Ethical opinion

The members of the Committee taking part in the review gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

Discussion: There were no ethical concerns raised.

Approved documents

The documents reviewed and approved at the meeting were:

<i>Document</i>	<i>Version</i>	<i>Date</i>
Covering letter on headed paper [Letter to REC_IRAS 198880_substantial amendment 3_13.9.2018.docx]	3	13 September 2018
Notice of Substantial Amendment (non-CTIMP) [Substantial Amendment 3 - 198880.pdf]	3	13 September 2018
Other [HRA Schedule of events IRAS 198880 - V3_13.9.2018.xls]	3	13 September 2018
Participant information sheet (PIS) [Participant Information Sheet RA_IRAS 198880 - V5_13.9.2018.docx]	5	13 September 2018
Research protocol or project proposal [Protocol_IRAS 198880 - V3_13.9.2018.docx]	3	13 September 2018
Validated questionnaire [Questionnaire - bodily pain (SF-36) - V1_13.9.2018.pdf]	1	13 September 2018
Validated questionnaire [Questionnaire - CAP Knee Scale - V1_13.9.2018.pdf]	1	13 September 2018

Membership of the Committee

The members of the Committee who took part in the review are listed on the attached sheet.

Working with NHS Care Organisations

Sponsors should ensure that they notify the R&D office for the relevant NHS care organisation of this amendment in line with the terms detailed in the categorisation email issued by the lead nation for the study.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

We are pleased to welcome researchers and R & D staff at our Research Ethics Committee members' training days – see details at <http://www.hra.nhs.uk/hra-training/>

16/WM/0371:	Please quote this number on all correspondence
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Yours sincerely

Dr Hilary Paniagua
Chair

4.2 Letter of invitation to participants and advertising poster

Russells Hall Hospital
Pensnett Road
Dudley
DY1 2HQ

Telephone: 01384 456111
Fax: 01384 244051

Dear participant,

The University of Birmingham would like to invite you to participate in a research project. The project is called “**Sedentary Behaviour and Physical Activity in Rheumatoid Arthritis and Osteoarthritis**”.

The purpose of this project is to better understand the determinants and health consequences of physical activity and sedentary behaviour (time spent sitting and lying) in people living with Rheumatoid Arthritis and Osteoarthritis.

Please find enclosed a participant information sheet which explains the aims of this research in more detail. The information sheet also outlines what you will be asked to do should you wish to participate in the study, and also explains how you can get involved in the project if you decide you would like to take part.

Thank you very much for taking the time to read this information and for considering participation in this study.

With best wishes,

Sincerely,

Dr. Sally Fenton, Professor Joan Duda, Dr. Alison Rushton, Dr Jet Veldhuijzen van Zanten, Miss Ciara O’Brien and Miss Archontissa Kanavaki
School of Sport, Exercise and Rehabilitation Sciences
University of Birmingham
Birmingham

Professor George Kitas and Dr Rainer Klocke
Rheumatology Department, Russells Hall Hospital (Dudley
Group of Hospitals NHS Foundation Trust)

Dr. Abishek Abishek
Faculty of Medicine and Health Sciences,
University of Nottingham
Nottingham

Professor George Metsios
Institute of Sport
University of Wolverhampton
Wolverhampton



Do you have **knee or hip osteoarthritis**?

Would you like to take part in a study to help us find out:

Physical activity, can it help with joint pain and mobility? What helps you be more active?

Sitting too much, how bad is it?

What is the study about?

Studies show that exercise is important for the management hip and knee osteoarthritis. We would like to find out more about how daily physical activities and sitting time affect your joint pain, mobility, general health and well-being. Also, what helps you move more or sit less.

Answering these questions will help develop more effective ways to help people with osteoarthritis manage their symptoms and improve their health and quality of life.

What will we ask you to do?

One visit at Russells Hall or Corbett Hospital to complete some questionnaires

- Use a waist-worn activity monitor for a week

You can find out about your physical activity and body fat and muscle mass. We offer tea and £10.

We will ask you **not** to participate if you have other forms of arthritis or you are not able to ambulate independently.

For further information please contact: Archontissa Kanavaki, Doctoral
Researcher ,

4.3 Questionnaire package

Physical activity in hip and knee osteoarthritis

Below we will ask you questions about your health, well-being, social and physical environment. These are factors that might help or prevent individuals living with osteoarthritis from being more active. By understanding individuals' experience we can develop more effective ways as part of health-care provision to help people sit less/ be more active and improve their symptoms, general health and well-being.

Your participation in this study is voluntary, but valuable. You may stop at any point if you wish. We kindly ask you to respond to all questions if possible. There are no right or wrong answers, please respond in a way that best reflects your personal experience.

Thank you very much for your time and effort!

Before you begin we would like to ask you to answer a few general questions about yourself.

Please circle the correct answer or fill in the space provided.

- What is your gender? Male Female
- What is your ethnic background?
- What is your date of birth?/...../..... (Day/ Month/ Year)
- What is the highest education you have received?

GCSE/0 Level A-Level/GCE University Degree Other (please specify:).....

- What is your marital status?

Married Living with partner Single Divorced Widowed Other (please specify:).....

- What is your work status?

Employed full-time Employed part-time Retired Unemployed Unable to work
Other.....

- If you are employed, what are you doing for a living?
.....
- How difficult is it for you to meet the monthly payments of your bills?

Extremely difficult Very difficult Somewhat difficult Slightly difficult Not difficult at all

- Do you receive any financial aid due to your hip/ knee condition? Yes No
- Are you a carer? Yes No
- Do you have a family history of knee/ hip osteoarthritis? Yes No
- Do you have a history of knee/ hip injury? Yes No
 - ...of knee/ hip surgery? Yes No
 - ...of knee/ hip injections? Yes No If yes,
number:....

- Are you able to walk without a walking aid? Yes No
- If any, what medication/ supplements are you taking for your joint symptoms?

.....
.....

- If any, please mention health conditions/ diagnoses you might currently have:
.....
.....
.....
.....
- If any, please mention important stressful life events you have experienced during the past year:
.....
- On the scale below, please place a mark at the point you feel that best represents the pain you have experienced on average during the last 30 days due to your hip or knee:

No pain at all _____ Worst pain imaginable

- On the scale below, please place a mark at the point you feel that best represents the pain you have experienced on average during the last 30 days due to conditions other than your hip/ knee:

No pain at all _____ Worst pain imaginable

Please tick the statement that best describes your current experience with physical activity:

..... I currently don't engage in physical activities and I do not intend to start doing so.

..... I currently don't engage in physical activities, but I have been thinking about becoming more active in the next few months.

..... I engage in physical activities, but not regularly.

..... I engage in physical activities regularly. I have been doing so for less than six months.

..... I engage in physical activities regularly. I have been doing so for more than six months.

Knee survey

Instructions: This survey asks for your view about your knee(s). This information will help us keep track of how you feel about your knee and how well you are able to perform your usual activities. Please answer every question by ticking the appropriate box, only one box for each question. If you are unsure about how to answer a question, please give the best answer you can.

Symptoms. These questions should be answered thinking of your knee symptoms during the **last week**.

S1. Do you have swelling in your knee?

Never ☐ Rarely ☐ Sometimes ☐ Often ☐ Always ☐

S2. Do you feel grinding, hear clicking or any other type of noise when your knee moves?

Never ☐ Rarely ☐ Sometimes ☐ Often ☐ Always ☐

S3. Does your knee catch or hang up when moving?

Never ☐ Rarely ☐ Sometimes ☐ Often ☐ Always ☐

S4. Can you straighten your knee fully?

Never ☐ Rarely ☐ Sometimes ☐ Often ☐ Always ☐

S5. Can you bend your knee fully?

Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never ☐

Stiffness. The following questions concern the amount of joint stiffness you have experienced during the **last week** in your knee. Stiffness is a sensation of restriction or slowness in the ease with which you move your knee joint.

S6. How severe is your knee joint stiffness after first wakening in the morning?

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

S7. How severe is your knee stiffness after sitting, lying or resting **later in the day**?

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

Pain

P1. How often do you experience knee pain?

Never ☐ Monthly ☐ Weekly ☐ Daily ☐ Always ☐

What amount of knee **pain** have you experienced **last week** during the following activities?

P2. Twisting/ Pivoting on your knee

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

P3. Straightening knee fully

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

P4. Bending knee fully

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

P5. Walking on flat surface

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

P6. Going up or down stairs

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

P7. At night while in bed

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

P8. Sitting or lying

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

P9. Standing upright

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

Function and daily living. The following questions concern your physical function. By this we mean your ability to move around and to look after yourself. For each of the following activities please indicate the **degree of difficulty** you have experienced in the **last week** due to your knee.

A1. Descending stairs

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A2. Ascending stairs

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

For each of the following activities please indicate the **degree of difficulty** you have experienced in the **last week** due to your knee.

A3. Rising from sitting

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A4. Standing

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A5. Bending to floor/ pick up an object

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A6. Walking on flat surface

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A7. Getting in/ out of car

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A8. Going shopping

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A9. Putting socks/ stockings

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A10. Rising from bed

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A11. Taking off socks/ stockings

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A12. Lying in bed (turning over, maintaining knee position)

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A13. Getting in/ out of bath

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A14. Sitting

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A15. Getting on/ off toilet

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

For each of the following activities please indicate the **degree of difficulty** you have experienced in the **last week** due to your knee.

A16. Heavy domestic duties (moving heavy boxes, scrubbing floors etc)

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

A17. Light domestic duties (cooking, dusting etc)

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

Function, sports and recreational activities. The following questions concern your physical function when being active on a higher level. The questions should be answered thinking of what degree of difficulty you have experienced during the **last week** due to your knee.

SP1. Squatting

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

SP2. Running

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

SP3. Jumping

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

SP4. Twisting/ pivoting on your osteoarthritic knee

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

SP5. Kneeling

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

Quality of Life

Q1. How often are you aware of your knee problem?

Never ☐ Monthly ☐ Weekly ☐ Daily ☐ Always ☐

Q2. How much are you troubled with lack of confidence in your knee?

Not at all ☐ Mildly ☐ Moderately ☐ Severely ☐ Totally ☐

Q3. In general, how much difficulty do you have with your knee?

None ☐ Mild ☐ Moderate ☐ Severe ☐ Extreme ☐

Q4. Have you modified your life style to avoid activities potentially damaging to your knee?

Not at all ☐ Mildly ☐ Moderately ☐ Severely ☐ Totally ☐

Quality of life questionnaire

This assessment asks how you feel about your quality of life, health or other areas of your life. If you are unsure about which response to give to a question, **please circle the one** that appears most appropriate based on how you feel. This can often be your first response. Please keep in mind your standards, hopes, pleasures and concerns. We ask what you think about your life in the **last two weeks**.

1. How would you rate your quality of life? Very poor Poor Neither poor nor good Good Very good

2. How satisfied are you with your health? Very dissatisfied Dissatisfied Neither satisfied nor dissatisfied Satisfied Very satisfied

The following questions ask about how much you have experienced certain things in the last two weeks.

3. To what extent do you feel that physical pain prevents you from doing what you need to do?	Not at all	A little	A moderate amount	Very much	An extreme amount
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4. How much do you need any medical treatment to function in your daily life?	Not at all	A little	A moderate amount	Very much	An extreme amount
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5. How much do you enjoy life?	Not at all	A little	A moderate amount	Very much	An extreme amount
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6. To what extent do you feel your life to be meaningful?	Not at all	A little	A moderate amount	Very much	An extreme amount
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7. How well are you able to concentrate?	Not at all	A little	A moderate amount	Very much	An extreme amount
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8. How safe do you feel in your daily life?	Not at all	A little	A moderate amount	Very much	An extreme amount
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9. How healthy is your physical environment?	Not at all	A little	A moderate amount	Very much	An extreme amount
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The following questions ask about **how completely** you experience or were able to do certain things in the **last two weeks**.

10. Do you have enough energy for everyday life?	Not at all	A little	Moderately	Mostly	Completely
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11. Are you able to accept your bodily appearance?	Not at all	A little	Moderately	Mostly	Completely
12. Have you enough money to meet your needs?	Not at all	A little	Moderately	Mostly	Completely
13. How available to you is the information that you need in your day-to-day life?	Not at all	A little	Moderately	Mostly	Completely
14. To what extent do you have the opportunity for leisure activities?	Not at all	A little	Moderately	Mostly	Completely
15. How well are you able to get around?	Not at all	A little	Moderately	Mostly	Completely

The following questions ask about how good or satisfied you have felt about various aspects of your life over the last two weeks.

16. How satisfied are you with your sleep?	Very dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Very satisfied
17. How satisfied are you with your ability to perform your daily living activities?	Very dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Very satisfied
18. How satisfied are you with your capacity for work?	Very dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Very satisfied

19. How satisfied are you with yourself?	Very dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Very satisfied
20. How satisfied are you with your personal relationships?	Very dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Very satisfied
21. How satisfied are you with your sex life?	Very dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Very satisfied
22. How satisfied are you with the support you get from your friends?	Very dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Very satisfied
23. How satisfied are you with the conditions of your living place?	Very dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Very satisfied
24. How satisfied are you with your access to health services?	Very dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Very satisfied
25. How satisfied are you with your transport?	Very dissatisfied	Dissatisfied	Neither satisfied or dissatisfied	Satisfied	Very satisfied
26. How often do you have negative feelings (blue mood, despair, anxiety)?				Very often	

	Never	Seldom	Quite often	Always
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(HADS)Instructions: Emotions play an important part in most illnesses. We would like to get a better of how you have been feeling recently. Please read each item and circle the reply which comes closest to how you have been feeling in the **past week**. Don't take too long over your replies: your immediate reaction to each item will probably be more accurate than a long thought out response.

I feel tense or 'wound up':		I feel as if I am slowed down:	
Most of the time	3	Nearly all of the time	3
A lot of the time	2	Very often	2
Time to time, occasionally	1	Sometimes	1
Not at all	0	Not at all	0
I still enjoy the things I used to enjoy:		I get a sort of frightened feeling like 'butterflies in the stomach':	
Definitely as much	0	Not at all	0
Not quite so much	1	Occasionally	1
Only a little	2	Quite often	2
Not at all	3	Very often	3
I get a sort of frightened feeling like something awful is about to happen:		I have lost interest in my appearance:	
Very definitely and quite badly	3	Definitely	3
Yes, but not too badly	2	I don't take as much care as I should	2
A little, but it doesn't worry me	1	I may not take quite as much care	1
Not at all	0	I take just as much care as ever	0
I can laugh and see the funny side of things:		I feel restless as if I have to be on the move:	
As much as I always could	0	Very much indeed	3
Not quite so much now	1	Quite a lot	2
Definitely not so much now	2	Not very much	1
Not at all	3	Not at all	0
Worrying thoughts go through my mind:		I look forward with enjoyment to things:	
A great deal of the time	3	A much as I ever did	0
A lot of the time	2	Rather less than I used to	1
From time to time but not too often	1	Definitely less than I used to	3
Only occasionally	0	Hardly at all	2
I feel cheerful:		I get sudden feelings of panic:	
Not at all	3	Very often indeed	3
Not often	2	Quite often	2
Sometimes	1	Not very often	1
Most of the time	0	Not at all	0
I can sit at ease and feel relaxed:		I can enjoy a good book or radio or TV programme:	
Definitely	0	Often	0
Usually	1	Sometimes	1

Not often	2	Not often	2
Not at all	3	Very seldom	3

Physical activity and reducing sedentary behaviour (sitting time)

Term	Definition
Physical activity	Any movement by your body that works your muscles, and requires energy greater than resting (in contrast to sitting or lying down). Examples: walking the dog, gardening, dancing, swimming, exercise classes.
Reducing sedentary behaviour (sitting time)	Refers to your overall attempts to spend less time sitting or lying down, <i>including</i> your attempts to more frequently interrupt periods of sitting with physical activity or standing (i.e., which is called breaking up your sitting time). Examples: <ul style="list-style-type: none"> • Going somewhere on foot instead of taking the car or the bus. • Deciding not to watch TV for an hour, but go out for a walk instead. • Whilst watching TV or using your computer, you stand up occasionally, e.g. during breaks in the programme. • Whilst reclining and reading a book, you stand up every few pages you read.

Physical activity expectations

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. Physical activity will improve my ability to perform daily activities.					
2. Physical activity will improve my social standing.					
3. Physical activity will improve my overall body functioning.					
4. Physical activity will help manage stress.					
5. Physical activity will strengthen my bones.					
6. Physical activity will improve my mood.					
7. Physical activity will increase my muscle strength.					
8. Physical activity will make me more at ease with people.					
9. Physical activity will aid in weight control.					
10. Physical activity will improve my psychological state.					
11. Physical activity will provide companionship.					
12. Physical activity will improve the functioning of my cardiovascular system.					
13. Physical activity will increase my mental alertness.					
14. Physical activity will increase my acceptance by others.					
15. Physical activity will give me a sense of personal accomplishment.					

SE-PA The statements bellow are about how confident you feel that you would take part in physical activities under the various circumstances described (which can put people off doing physical activities). If it is very unlikely that you would do the activity (not confident) then your response should be towards 1. If you would do the activity no matter what (very confident), then your response should be towards 10.

I would take part in physical activity (e.g., walking) five times per week for 30 mins (or other frequency/ duration, but still about 150 mins/week in total) if...	1 = Not confident (I wouldn't do it) 10 = Very confident (I would do it)									
1. The weather was bothering me	1	2	3	4	5	6	7	8	9	10
2. I was bored by the programme or activity	1	2	3	4	5	6	7	8	9	10
3. I felt pain when being physically active	1	2	3	4	5	6	7	8	9	10
4. I had to do it alone	1	2	3	4	5	6	7	8	9	10
5. I did not enjoy doing it	1	2	3	4	5	6	7	8	9	10
6. I was too busy with other activities/tasks	1	2	3	4	5	6	7	8	9	10
7. I felt tired	1	2	3	4	5	6	7	8	9	10
8. I felt stressed	1	2	3	4	5	6	7	8	9	10
9. I felt depressed	1	2	3	4	5	6	7	8	9	10

PNS: Below are a number of statements relating to your personal experiences of physical activity (i.e., how you are feeling when engaging in physical activity). Please indicate the extent to which you agree or disagree with each of the following statements; bear in mind how **you GENERALLY felt** during the **past 4 weeks**.

With regard to my experience of physical activity...	FalseTrue					
1. I feel that I am able to complete physical activities that are personally challenging	1	2	3	4	5	6
2. I feel free to be physically active in my own way	1	2	3	4	5	6
3. I feel attached to my physical activity companions because they accept me for who I am	1	2	3	4	5	6
4. I feel free to make my own decisions about when and where I am physically active	1	2	3	4	5	6
5. I feel confident I can do even the most challenging physical activities	1	2	3	4	5	6
6. I feel I share a common bond with people who are important to me when we take part in physical activity together	1	2	3	4	5	6
7. I feel confident in my ability to perform physical activities that are personally challenging to me	1	2	3	4	5	6
8. I feel like I am in charge of my physical activity decisions	1	2	3	4	5	6
9. I feel a sense of camaraderie with my physical activity companions because we take part in physical activity for the same reasons	1	2	3	4	5	6
10. I feel close to my physical activity companions who appreciate how difficult taking part in physical activity can be	1	2	3	4	5	6
11. I feel like I have a say in choosing the activities that I do	1	2	3	4	5	6
12. I feel capable of completing physical activities that are challenging to me	1	2	3	4	5	6
13. I feel free to choose which physical activities I take part in	1	2	3	4	5	6
14. I feel connected to the people I interact with while we engage in physical activity together	1	2	3	4	5	6
15. I feel like I am capable of doing even the most challenging physical activities	1	2	3	4	5	6
16. I feel good about the way I am able to complete challenging physical activities	1	2	3	4	5	6
17. I feel like I am the one who decides what physical activity I do	1	2	3	4	5	6

18. I feel like I get along well with other people who I interact with while we exercise together	1	2	3	4	5	6
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IOCQ: Who (e.g., partner, best friend, GP) is the most important person(s) in your effort to:

1. **Be physically**

☐

NOTE: Please select this person(s) and write your relationship to them on the dotted line. If you do not consider you have an important other in this

active.....

2. **Reduce your sitting**

☐

time.....

Please consider the support you feel this person gives to you with regard to being more active or sitting less. Please circle the number that best reflects the extent to which you agree or disagree with each statement.

Rating scale: Please circle one number from 1-7 in each of the three sections	Being more physically active							Reducing my sitting time						
	1 = Strongly			7 = Strongly				1 = Strongly			7 = Strongly			
1. I feel that my important other provides me with choices and options about this	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2. I feel my important other understands how I see things with respect to this	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3. My important other conveys confidence in my ability to do this	1	2	3	4	5	6	7	1	2	3	4	5	6	7
4. My important other listens to how I would like to do things regarding efforts to do this	1	2	3	4	5	6	7	1	2	3	4	5	6	7
5. My important other encourages me to ask questions about this to improve my health	1	2	3	4	5	6	7	1	2	3	4	5	6	7

6. My important other tries to understand how I see this before suggesting changes	1	2	3	4	5	6	7	1	2	3	4	5	6	7
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HCCQ: This section refers specifically to your visits to **your consultant(s)** during which physical activity and reducing your sitting time was discussed in any way. If you have discussed this with several consultants, please refer to your experience overall. Circle the number that best reflects the extent to which you agree or disagree with each statement.

NOTE: If you have not discussed these topics with your consultant(s), please place a cross in the box next to the corresponding behaviour and **do not**

Rating scale: Please circle one number from 1-7 in each of the three sections	Being more physically active <input type="checkbox"/>							Reducing my sedentary behaviour <input type="checkbox"/>						
	1 = Strongly							1 = Strongly						
1. I feel that my consultant provides me with choices and options about this	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2. I feel my consultant understands how I see things with respect to this	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3. My consultant conveys confidence in my ability to do this	1	2	3	4	5	6	7	1	2	3	4	5	6	7
4. My consultant listens to how I would like to do things regarding efforts to do this	1	2	3	4	5	6	7	1	2	3	4	5	6	7
5. My consultant encourages me to ask questions about this to improve my health	1	2	3	4	5	6	7	1	2	3	4	5	6	7
6. My consultant tries to understand how I see this before suggesting changes	1	2	3	4	5	6	7	1	2	3	4	5	6	7

BREQ: Please indicate to what extent you agree or disagree with each of the following statements with regard to being physically active and reducing your sitting time by circling a number in the table below; bear in mind how **you GENERALLY felt** during the **past 4 weeks**.

	I am physically active...					I aim to reduce my sitting time...				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Because other people say I should	1	2	3	4	5	1	2	3	4	5
2. Because I feel guilty when I am not doing this	1	2	3	4	5	1	2	3	4	5
3. Because I value the benefits of doing this	1	2	3	4	5	1	2	3	4	5
4. Because it is fun	1	2	3	4	5	1	2	3	4	5
5. But I don't see why I should	1	2	3	4	5	1	2	3	4	5
6. Because my friends and family say I should	1	2	3	4	5	1	2	3	4	5
7. Because I feel ashamed when I am not doing this	1	2	3	4	5	1	2	3	4	5
8. Because it is important for me to try to do this on a regular basis	1	2	3	4	5	1	2	3	4	5
9. But I can't see why I should bother	1	2	3	4	5	1	2	3	4	5
10. Because I enjoy doing this	1	2	3	4	5	1	2	3	4	5
11. Because others will not be pleased with me if I am not doing this	1	2	3	4	5	1	2	3	4	5
12. But I don't see the point in doing this	1	2	3	4	5	1	2	3	4	5
13. Because I felt like a failure when I have not been doing this in a while	1	2	3	4	5	1	2	3	4	5
14. Because I think it is important to make the effort to do this regularly	1	2	3	4	5	1	2	3	4	5
15. Because I find doing this pleasurable	1	2	3	4	5	1	2	3	4	5
16. Because I feel under pressure from others to do this	1	2	3	4	5	1	2	3	4	5
17. Because I get restless if I am not doing this regularly	1	2	3	4	5	1	2	3	4	5

18. Because I get pleasure and satisfaction from doing this	1	2	3	4	5	1	2	3	4	5
19. But I think doing this is a waste of time	1	2	3	4	5	1	2	3	4	5

Your home and neighbourhood environment

The questions included in **Sections A, B, C and D** ask about the environment around you, both inside and outside your home.

Home Environment

Section A: Please respond to the following questions.

1. How many televisions are in your home?				
2. Which rooms do you have televisions in	Kitchen	Living Room	Bedroom	Other rooms (please specify).....
3. Do you have stairs at home?	Yes		No	
4. How many people live in your home (not including you)?				
5. Please tell us the age(s) of other people who live in your home (not including you):				

Section B: Please respond to the following questions by putting one check mark (✓) per answer, stating 'yes' or 'no'.

	Yes	No
a) Do you have a bicycle for your personal use?		
b) Do you have a garden (including a yard, allotment or city garden)?		
c) Do you have small sports equipment such as a ball, racquets, for your personal use?		
d) Do you have exercise equipment such as weights, treadmill, stationary cycle, for your personal use?		
e) Do you have access to a car?		
f) Do you have a dog?		

Physical Environment

Section C: Please respond to each of the following statements by circling a number to tell us how much you agree or disagree with them.

	Strongly disagree			Strongly agree
7. There are many shops to buy things within easy walking distance of my home	1	2	3	4
8. There are many alternative routes for getting from place to place when walking in my area	1	2	3	4
9. There are footpaths on all of the streets in my local area	1	2	3	4
10. There is a park or nature reserve in my local area that are easy to get to	1	2	3	4
11. There are bicycle or walkway tracks in my local area that are easy to get to	1	2	3	4
12. My local neighbourhood is attractive	1	2	3	4
13. There are pleasant natural features in my local area	1	2	3	4
14. There is so much local traffic along most nearby streets that make it difficult/unpleasant to walk	1	2	3	4
15. I feel safe walking in my local area during the day	1	2	3	4

Section C (ALPHA): We would like to find out more information about the way that you think about your neighbourhood, home environment and workplace or study environment. Please answer as honestly and completely as possible and provide only one answer for each item. There are no right or wrong answers.

1. Types of residences in your neighbourhood

NOTE: By your neighbourhood, we mean ALL the area that you could walk to in 10-15

How common are the following types of residences in your immediate neighbourhood?

Please put one check mark (✓) per answer that best applies to your view of your neighbourhood.

	None	A few	Some	Most	All
Detached houses					
Semi-detached houses or terraced houses					
Apartment buildings or blocks of flats					

2. Distance to local facilities

About how long would it take to get from your home to the *nearest* businesses or facilities listed below if you WALKED to them?

Please put one check mark (✓) for each business or facility.

The nearest...	1-5 min	6-10 min	11-20 min	21-30 min	More than 30 min
a) Local shops such as a grocery shop, bakery, butcher etc.					
b) Supermarket					
c) Local services such as a bank, post office or library					
d) Restaurant, café, pub or bar					

e) Fast-food restaurant or takeaway					
f) Bus stop, tram, metro or train station					
g) Sport and leisure facility such as a swimming pool, sports field or fitness centre					
h) Open recreation area such as a park or other open space					

3. Walking infrastructure in your neighbourhood

NOTE: By your neighbourhood, we mean ALL the area that you could walk to in 10-15 minutes.

Please circle one answer per statement.

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
a) There are pavements in my neighbourhood	1	2	3	4
b) There are pedestrian zones or pedestrian trails in my neighbourhood	1	2	3	4

4. Maintenance of walking infrastructure in your neighbourhood

NOTE: By your neighbourhood, we mean ALL the area that you could walk to in 10-15 minutes.

Please circle one answer per statement.

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Not applicable
a) The sidewalks in my neighbourhood are well maintained	1	2	3	4	5
b) The play areas, playgrounds, parks or other open spaces in my neighbourhood are well maintained	1	2	3	4	5

5. Neighbourhood safety

NOTE: By your neighbourhood, we mean ALL that you could walk to in 10-15 minutes.

Please circle one answer per statement.

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
a) There are not enough safe places to cross busy streets in my neighbourhood	1	2	3	4
b) Walking is dangerous because of the traffic in my neighbourhood	1	2	3	4
c) It is dangerous in my neighbourhood during the day because of the level of crime	1	2	3	4
d) It is dangerous in my neighbourhood during the night because of the level of crime	1	2	3	4

6. How pleasant is your neighbourhood for walking?

NOTE: By your neighbourhood, we mean ALL the area that you could walk to in 10-15 minutes.

Please circle one answer per statement.

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
a) My local neighbourhood is a pleasant environment for walking	1	2	3	4
	None	A few	Some	Plenty
b) There is litter or graffiti in the streets of my neighbourhood	1	2	3	4
c) There are trees along the streets in my neighbourhood	1	2	3	4
d) In my neighbourhood there are badly maintained, unoccupied or ugly buildings	1	2	3	4

7. Walking network

NOTE: By your neighbourhood, we mean ALL the area that you could walk to in 10-15 minutes.

Please circle one answer per statement.

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
a) There are many shortcuts for walking in my neighbourhood	1	2	3	4
b) There are many road junctions in my neighbourhood	1	2	3	4
c) There are many different routes for walking from place to place in my neighbourhood so I don't have to go the same way every time	1	2	3	4

8. Workplace or study environment

A. How far do you have to travel to get to your usual place of work or study?

- ☐ I do not work or study – please skip part B
- ☐ I usually work at home or from home – please check the box (✓) and skip part B
- ☐ I work part-time – please check the box (✓) and skip part B
- ☐ The distance to my work or place of study is kilometres/miles – please complete part B

B. At your work or place of study, do you have...

	Yes	No
a) ...escalators or lifts?		
b) ...stairs?		
c) ...fitness centre/equipment?		
d) ...bicycles provided by employer or school?		
e) ...a safe place to leave a bike?		
f) ...enough car parking spaces?		
g) ...showers and changing rooms?		
h) ...exercise classes (e.g. aerobics classes) ?		
i) ...sports club/association (e.g. running club)?		
j) ...employer/school subsidised public transport?		

SCHOOL OF SPORT, EXERCISE AND REHABILITATION SCIENCES

Archontissa Kanavaki, Doctoral Researcher
School of Sport, Exercise & Rehabilitation Sciences
University of Birmingham
B15 2TT, Edgbaston
Birmingham, United Kingdom



Date - _____

Study title - Physical activity and sedentary behaviours in hip and knee osteoarthritis

To Finance Office, University of Birmingham

I confirm that I have received £..... from Archontissa Kanavaki in cash reimbursement for taking part in the above study on the date above.

Name - _____

Signature - _____

Activity monitor logbook

Please use this sheet to record all the times when you put on/take off the activity monitor for each day during the week, starting each day by writing the time you put the monitor on in the morning and finishing it by writing the last time you take the monitor off before going to bed.

Date:		Date:		Date:		Date:		Date:		Date:		Date:	
On		On		On		On		On		On		On	
Off		Off		Off		Off		Off		Off		Off	
On		On		On		On		On		On		On	
Off		Off		Off		Off		Off		Off		Off	
On		On		On		On		On		On		On	
Off		Off		Off		Off		Off		Off		Off	
On		On		On		On		On		On		On	
Off		Off		Off		Off		Off		Off		Off	

During this past week you have been (*Please circle as appropriate at the end of the 7-day period*):

1. As physically active as usual
than usual

2. Less physically active than usual

3. More physically active

4.4 Participant Information Sheet

Participant information sheet

Sedentary Behaviour and Physical Activity in Osteoarthritis

Chief investigator: Archontissa Kanavaki, Doctoral Researcher

You are being asked to take part in a research study. Before you decide whether you are willing to take part it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

1. What is the study about?

The aim of the study is to better understand the determinants and health consequences of physical activity and sedentary behaviour (i.e. time spent sitting or lying) in people who live with knee and hip Osteoarthritis. Pain and compromised physical function are integral part of OA, yet some individuals make an effort to be physically active, while the majority is physically inactive. Understanding what makes people with osteoarthritis move more and what makes them sit more is important in identifying effective practices to help them become more active and improve their health and quality of life.

2. Who is organising and funding the research?

The Medical Research Council and Arthritis Research UK funds the researcher Archontissa Kanavaki, who will be carrying out this study as part of her work for her postgraduate degree.

3. Why are we asking you to participate and what are the exclusion criteria?

If you are above 45 years old and have a diagnosis of hip or knee osteoarthritis you are eligible to participate in this study.

Unfortunately, we will ask you not to participate if you have any other form of arthritis such as rheumatoid arthritis, fibromyalgia, gout; if you are unable to ambulate independently (if you use a walking stick you are still eligible); if you have any condition that causes significant memory loss.

4. What will we ask you to do?

If you decide to take part in the study, we will ask you to complete two “study weeks” six months apart. Each study week involves: one visit, lasting 1-1.5 hours, To Dudley Group of Hospitals NHS Trust where (a) you will fill in some questionnaires, (b) we will measure your height, weight, body composition and resting blood pressure and (c) give you a waist-worn accelerometer to take home and wear for a week.

We will ask you to repeat the same procedure six months later, provided that you are still willing to participate. During these six months, no intervention will take place and you will be receiving your usual health-care. Please see section 12 for a detailed description of all procedures.

5. What are the possible disadvantages and risks of taking part?

There are no known risks to taking part. You may feel uncomfortable wearing the GT3X accelerometer for a 7-day period, but you are able to remove it at any time, withdraw your consent from participation in the study should you wish.

6. What are the potential benefits of taking part?

Upon completion of the study, we will be able to give you feedback on some aspects of your general health (e.g. body composition, blood pressure). In addition, once you have worn the GT3X monitor for 7 days, we will be able to provide information relating to how much time you spent sitting or doing light, moderate and vigorous activities. Finally, we will also be able to provide you with details of the results of the study once the data has been analysed and published in scientific journals.

7. Will there be reimbursement for participating in the study?

Yes, we offer a reimbursement of £10 for each visit (fixed amount) for your travel expenses. We will ask you to sign a confirmation form upon receiving the amount.

8. How will we maintain your privacy and confidentiality?

The records of this study will be kept private and confidential. Data related to you will be kept anonymous during analyses and reporting. All research records will be kept in secure, locked cabinets/ rooms in the School of Sport, Exercise and Rehabilitation Sciences, UoB. Electronic data will be kept on a password-protected University computer and/or encrypted storage device. Only the study researchers will have access to your personal details, strictly for study purposes.

The information will be processed by the University of Birmingham in accordance with the provisions of the Data Protection Act 1998.

9. Can I withdraw my participation?

You may decide to withdraw from the study at any time before or during the study, for any reason. Withdrawal will not influence the health-care you are receiving. In this case your data will be destroyed and will not be included in the analysis. If you decide to withdraw after a visit has taken place, you may do so at any point within 20 days from the day of your visit. After this period the results will be analysed and may be written up for publication, so withdrawal will not be possible.

10. What will happen to the results of the research project?

The findings of the study will be written up as part of a doctoral dissertation. In addition, findings may be published in academic journals but will not contain identifiable information. If you would like to receive a full summary of the findings of the study, please contact the researchers (details below).

11. Who has reviewed this study?

This study has been reviewed by the local Research Ethics Committee (REC) and the Health Research Authority. It will be run in accordance with all suitable guidelines aimed at ensuring proper conduct and safety of anyone taking part, including the Guidelines on Good Clinical Practice and the Declaration of Helsinki.

12. All study procedures are explained in detail below:

First it is essential that you provide us with your written consent to take part in this project.

Next, during each of your visits to the Dudley Group of Hospitals the researcher Archontissa Kanavaki will carry out the following assessments:

- Measurements of height, weight, and body composition using the Tanita Scale. After measurement of your height, you will be asked to stand on the scales and hold the handles at your side for 20 seconds. This will tell us the composition of your body, in terms of the amount of muscle, fat, water and bone.

- Resting blood pressure, using routine hospital procedures after you have rested for 5 minutes.
- 20-metre timed walk. This measures your speed and physical function. We will ask you to wear comfortable shoes and walk at a comfortable pace from a 'start line' to a 'finish line' which are 20 metres apart. The researcher will record the amount of time taken to complete the task.
- Questionnaires. You will be asked to complete a series of questionnaires that will assess your health and well-being (e.g. pain, sleep quality, vitality, anxiety, motivation to be physically active); your perceptions of the support for physical activity that you have from health professionals and important others; your perceptions of your physical environment (e.g. how close is your home to green space).

Next, you will be invited to wear a physical activity monitor (GT3X accelerometer) for 7 days (i.e., 'the study week') and to only remove it for sleeping/ bathing/ water-based activities. The GT3X is a light (27g) and small device (3.8 x 3.7 x 1.8 cm) worn on an elasticated strap on the waist on the right hip. It can be worn on top of or underneath your clothes. It should not feel uncomfortable, in case it does it may be removed.

We will provide you with a monitor log for each device, and will ask that you make a note of time periods during which the GT3X was removed. You will also be given a physical activity diary to take home and complete for 3 days during the 7-day study week. In this diary, you can briefly report the activity being undertaken at 15-minute time intervals for each day.

Following the 7-day period, we will remind you to send the accelerometer, monitor log and diary back in a pre-paid envelope, or we can collect it if this is more convenient.

Harm: If you have an accident such as a fall, while undertaking any of the procedures in the hospital, Dudley Group of Hospitals NHS Foundation Trust has the indemnity for this study. The researchers carrying out the study protocol are trained with regards to the procedures used. In addition, the Clinical Research Facility is staffed with research nurses should any incident occur. You are also able to have a friend or family member accompany you to the hospital should you wish.

Contact: If you have questions or concerns please contact Archontissa Kanavaki, Doctoral Researcher at [REDACTED] or [REDACTED]. You may also contact one of the faculty members supervising this project Dr Sally Fenton, Research Fellow at [REDACTED] or [REDACTED].

The Patient Advice and Liaison Service can also be contacted to answer any queries you may have about participating in this study. You can contact PALS by email at pals@dgh.nhs.uk, by freephone on 0800-0730510, or you can write to: PALS Department, Russells Hall Hospital, Dudley, West Midlands, DY1 2HQ

Thank you for taking the time to read this information sheet.

Appendix 5

The STROBE statement

	Item No	Recommendation	Thesis Page
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	93
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	n/a
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	94-98
Objectives	3	State specific objectives, including any prespecified hypotheses	98
Methods			
Study design	4	Present key elements of study design early in the paper	99
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	99 (also 79-81)
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	100 (also 81)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	81-82
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	84-91, 101-102
Bias	9	Describe any efforts to address potential sources of bias	80-81
Study size	10	Explain how the study size was arrived at	92
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	102-104
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	104-105
		(b) Describe any methods used to examine subgroups and interactions	n/a
		(c) Explain how missing data were addressed	103-104
		(d) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(e) Describe any sensitivity analyses	n/a

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	100, 105
		(b) Give reasons for non-participation at each stage	99
		(c) Consider use of a flow diagram	100
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	105-108
		(b) Indicate number of participants with missing data for each variable of interest	108
Outcome data	15*	Report numbers of outcome events or summary measures	106-107
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(b) Report category boundaries when continuous variables were categorized	110
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	115-116
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	118
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	115-117
Generalisability	21	Discuss the generalisability (external validity) of the study results	117
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	n/a

Appendix 6

6.1 Ethics letters of approval

Letter of HRA Approval for a study processed through pre-HRA Approval systems

Study title: Physical activity in people living with hip or knee osteoarthritis
IRAS project ID: 185665
Sponsor University of Birmingham

Professor Joan Duda

Professor of Sport and Exercise Psychology Email: hra.approval@nhs.net University of Birmingham

School of Sport and Exercise Sciences
Edgbaston, Birmingham
B15 2TT

24 October 2016

Dear Professor Duda,

Thank you for your request for HRA Approval to be issued for the above referenced study.

I am pleased to confirm that the study has been given **HRA Approval**. This has been issued on the basis that the study is compliant with the UK wide standards for research in the NHS.

The extension of HRA Approval to this study on this basis allows the sponsor and participating NHS organisations in England to set-up the study in accordance with HRA Approval processes, with decisions on study set-up being taken on the basis of capacity and capability alone.

If you have submitted an amendment to the HRA between 23 March 2016 and the date of this letter, this letter incorporates the HRA Approval for that amendment, which may be implemented in accordance with the amendment categorisation email (e.g. not prior to

REC Favourable Opinion, MHRA Clinical Trial Authorisation etc., as applicable). If the submitted amendment included the addition of a new NHS organisation in England, the addition of the new NHS organisation is also approved and should be set up in accordance with HRA Approval processes (e.g. the organisation should be invited to assess and arrange its capacity and capability to deliver the study and confirm once it is ready to do so).

Participation of NHS Organisations in England

Please note that full information to enable set up of participating NHS organisations in England is not provided in this letter, on the basis that activities to set up these NHS organisations is likely to be underway already.

The sponsor should provide a copy of this letter, together with the local document package and a list of the documents provided, to participating NHS organisations in England that are being set up in accordance with [HRA Approval Processes](#). It is for the sponsor to ensure that any documents provided to participating organisations are the current, approved documents.

For non-commercial studies the local document package should include an appropriate [Statement of Activities and HRA Schedule of Events](#). The sponsor should also provide the template agreement to be used in the study, where the sponsor is using an agreement in addition to the Statement of Activities. Participating NHS organisations in England should be aware that the Statement of Activities and HRA Schedule of Events for this study have not been assessed and validated by the HRA. Any changes that are appropriate to the content of the Statement of Activities and HRA Schedule of Events should be agreed in a pragmatic fashion as part of the process of assessing, arranging and confirming capacity and capability to deliver the study. If subsequent NHS organisations in England are added, an amendment should be submitted to the HRA..

For commercial studies the local document package should include a validated industry costing template and the template agreement to be used with participating NHS organisations in England.

It is critical that you involve both the research management function (e.g. R&D office and, if the study is on the NIHR portfolio, the LCRN) supporting each organisation and the local research team (where there is one) in setting up your study. Contact details and further information about working with the research management function for each organisation can be accessed from www.hra.nhs.uk/hra-approval.

After HRA Approval

In addition to the document, “*After Ethical Review – guidance for sponsors and investigators*”, issued with your REC Favourable Opinion, please note the following:

- ☐ HRA Approval applies for the duration of your REC favourable opinion, unless otherwise notified in writing by the HRA.
- ☐ Substantial amendments should be submitted directly to the Research Ethics Committee, as detailed in the *After Ethical Review* document. Non-substantial amendments should be submitted for review by the HRA using the form provided on the [HRA website](#), and emailed to hra.amendments@nhs.net.
- ☐ The HRA will categorise amendments (substantial and non-substantial) and issue confirmation of continued HRA Approval. Further details can be found on the [HRA website](#).

Scope

HRA Approval provides an approval for research involving patients or staff in NHS organisations in England.

If your study involves NHS organisations in other countries in the UK, please contact the relevant national coordinating functions for support and advice. Further information can be found at <http://www.hra.nhs.uk/resources/applying-for-reviews/nhs-hsc-rd-review/>.

If there are participating non-NHS organisations, local agreement should be obtained in accordance with the procedures of the local participating non-NHS organisation.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please email the HRA at hra.approval@nhs.net. Additionally, one of our staff would be happy to call and discuss your experience of HRA Approval.

HRA Training

We are pleased to welcome researchers and research management staff at our training days – see details at <http://www.hra.nhs.uk/hra-training/>.

If you have any queries about the issue of this letter please, in the first instance, see the further information provided in the question and answer document on the [HRA website](#).

Your IRAS project ID is 185665. Please quote this on all correspondence.

Yours sincerely

Simon Connolly

Senior Assessor

Email: hra.approval@nhs.net

West Midlands - Coventry & Warwickshire Research Ethics Committee

The Old Chapel
Royal Standard Place
Nottingham
NG1 6FS

Telephone:

21 January 2016
Professor Joan Duda
Professor of Sport and Exercise Psychology
University of Birmingham
School of Sport and Exercise Sciences University of Birmingham Edgbaston Birmingham
B152TT

Dear Professor Duda

Study title:	Physical activity in people living with hip or knee osteoarthritis
REC reference:	16/WM/0070
IRAS project ID:	185665

Thank you for your application for ethical review, which was received on 21 January 2016. I can confirm that the application is valid and will be reviewed by the Proportionate Review Sub-Committee on 27 January 2016. To enable the Proportionate Review Sub Committee to provide you with a final opinion within 10 working days your application documentation will be sent by email to Committee members.

One of the REC members is appointed as the lead reviewer for each application reviewed by the Sub-Committee. I will let you know the name of the lead reviewer for your application as soon as this is known.

Please note that the lead reviewer may wish to contact you by phone or email between 22/01/2016 and 26/01/2016 to clarify any points that might be raised by members and assist the Sub-Committee in reaching a decision.

If you will not be available between these dates, you are welcome to nominate another key investigator or a representative of the study sponsor who would be able to respond to the lead reviewer's queries on your behalf. If this is your preferred option, please identify this person to us and ensure we have their contact details.

You are not required to attend a meeting of the Proportionate Review Sub-Committee.

Please do not send any further documentation or revised documentation prior to the review unless requested.

Documents received

The documents to be reviewed are as follows:

<i>Document</i>	<i>Version</i>	<i>Date</i>
Copies of advertisement materials for research participants [Recruitment poster]	1	21 January 2016
Interview schedules or topic guides for participants [Interview Schedule]	1	21 January 2016
IRAS Checklist XML [Checklist_21012016]		21 January 2016
Non-validated questionnaire [Screening questionnaire]	1	21 January 2016
Participant consent form [Participant consent form]	1	21 January 2016
Participant information sheet (PIS) [Participant Information sheet]	1	21 January 2016
REC Application Form [REC_Form_21012016]		21 January 2016
Research protocol or project proposal [Research protocol]	1	21 January 2016
Summary CV for Chief Investigator (CI) [CV JL Duda]	1	21 January 2016
Summary CV for student [CV A Kanavaki]	1	21 January 2016
Summary CV for supervisor (student research) [CV A. Rushton]	1	21 January 2016
Summary, synopsis or diagram (flowchart) of protocol in non-technical language [Study flow charts]	1	21 January 2016

No changes may be made to the application before the meeting. If you envisage that changes might be required, you are advised to withdraw the application and re-submit it.

Notification of the Sub-Committee's decision

We aim to notify the outcome of the Sub-Committee review to you in writing within 10 working days from the date of receipt of a valid application.

If the Sub-Committee is unable to give an opinion because the application raises material ethical issues requiring further discussion at a full meeting of a Research Ethics Committee, your application will be referred for review to the next available meeting. We will contact you to explain the arrangements for further review and check they are convenient for you. You will be notified of the final decision within 60 days of the date on which we originally received your application. If the first available meeting date offered to you is not suitable, you may request review by another REC. In this case the 60 day clock would be stopped and restarted from the closing date for applications submitted to that REC.

R&D approval

All researchers and local research collaborators who intend to participate in this study at sites in the National Health Service (NHS) or Health and Social Care (HSC) in Northern Ireland should apply to the R&D office for the relevant care organisation. A copy of the Site-Specific Information (SSI) Form should be included with the application for R&D approval. You should advise researchers and local collaborators accordingly.

The R&D approval process may take place at the same time as the ethical review. Final R&D approval will not be confirmed until after a favourable ethical opinion has been given by this Committee.

For guidance on applying for R&D approval, please contact the NHS R&D office at the lead site in the first instance. Further guidance resources for planning, setting up and conducting research in the NHS are listed at <http://www.rdforum.nhs.uk>. There is no requirement for separate Site-Specific Assessment as part of the ethical review of this research.

Communication with other bodies

All correspondence from the REC about the application will be copied to the research sponsor and to the R&D office for The Dudley Group NHS FT, Clinical Research Unit, Russell's Hall Hospital. It will be your responsibility to ensure that other investigators, research collaborators and NHS care organisation(s) involved in the study are kept informed of the progress of the review, as necessary.

HRA Training

We are pleased to welcome researchers and R&D staff at our training days – see details at <http://www.hra.nhs.uk/hra-training/>

16/WM/0070

Please quote this number on all correspondence

Yours sincerely



Teagan Allen
REC Assistant

Email:



6.2 Participant Information Sheet and consent form



Physical activity in people living with hip or knee osteoarthritis. A qualitative study.

The Dudley Group 
NHS Foundation Trust

You are being asked to take part in a research study. Before you decide whether you are willing to take part it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

What is the study about?

The purpose of this study is to better understand what it means to live with hip or knee osteoarthritis, especially regarding the experience of being less or more physically active.

What are the exclusion criteria?

Unfortunately, we will ask you not to participate if you are younger than 45 years of age; if you have been diagnosed with other forms of arthritis, such as rheumatoid arthritis; if you have other medical conditions that significantly affect your ability to exercise or your memory; if you are not fluent in English.

Who is organising the study?

Archontissa Kanavaki, Doctoral Researcher at the University of Birmingham, will carry out the research under the supervision of Prof. Joan Duda (UoB), Dr Alison Rushton (UoB), Dr Rainer Klocke (Russells Hall Hospital) and Dr Abhishek Abhishek (Nottingham City Hospital). This study will constitute part of a doctoral dissertation.

Why are we asking you to participate?

It is highly valuable from a health and well-being promotion perspective to gain an insight and understand as closely as possible the experience of the people who in the future will be the recipients of such policies. We feel that your experiences can contribute greatly to such an understanding.

What will we ask you to do?

If you agree to participate in this study we will contact you to arrange a meeting at a location of your choice (this can be the University of Russells Hall, Corbett Hospital or University of Birmingham). You will then take part in an interview or a focus group, depending on your preference and your availability.

You will be asked to talk about your experience of osteoarthritis, well-being and ill-being, personal meanings of being physically active and being sedentary and what drives you towards each of these pursuits. The interview is expected to take approximately 1 hour. With your permission, the interview will be audiotaped and transcribed so that what you say is recorded accurately.

In case you are further interested to find out about/ give us some feedback on the results of the study, we will be glad to contact you one more time, inform you of the results and receive your feedback.

What are the possible risks of the study?

We do not anticipate any risks to you participating in this study other than those encountered in everyday life. It is up to you to decide exactly what to share in the interview. If you feel upset by what you have shared, you can skip specific questions or if necessary, the interview can be stopped straight away.

What are the benefits of participating in the study?

Potential benefits for you are not expected to be other than the opportunity to share your experience and discuss important issues in your everyday life. However, by participating in this study you take part in a wider effort to improve the quality of care, services and quality of life of people living with lower limb osteoarthritis.

Will there be reimbursement for participating in the study?

Travel and parking expenses related to study participation *up to £12* will be reimbursed to you in cash (please provide us with the relevant receipts). We will also offer refreshments at the interview.

How will we maintain your privacy and confidentiality?

The records of this study will be kept private and confidential. Direct quotes from the interviews may be used anonymously in the outputs of this research but **we will not include any information that will make it possible to identify you in any report or publication resulting from this study**. Research records and questionnaires will be kept in secure, locked cabinets/ rooms in the School of Sport, Exercise and Rehabilitation Sciences, UoB. Electronic transcripts of the data will be kept on a password-protected University computer and/or encrypted storage device. All tape-recorded interviews will be destroyed as soon as they are transcribed. Only the study researchers will have access to the data. The information will be processed by the University of Birmingham in accordance with the provisions of the Data Protection Act 1998.

All focus group participants will be requested not to share what others in the group say with outside individuals. However, absolute confidentiality cannot be ensured in the case of focus groups.

Can I withdraw my participation?

You may decide to withdraw from the study at any time before or during the study, for any reason. Withdrawal will not influence how you are treated as a participant and in such a case your data

will be destroyed. If you decide to withdraw after the interview/ focus group has taken place, you may do so at any point within 20 days starting from the day of the interview. In this case, your data will be destroyed and will not be included in the analysis. After this period of time the results will be analysed and may be written up for publication, so withdrawal will not be possible.

What will happen to the results of the research project?

The findings of the study will be written up as part of a doctoral dissertation. In addition, findings may be published in academic journals but will not contain identifying information. If you would like to receive a full summary of the findings of the study please contact the researchers (details below).

Contact: If you have questions or concerns please contact Archontissa Kanavaki at [redacted] or [redacted]. You may also contact the faculty members supervising this project Professor Joan L. Duda at [redacted] or [redacted]; Dr Alison Rushton at [redacted] or [redacted].

For information or concerns related to your health-care, please contact the Patient Advice and Liaison Service (PALS) on (0800) 073 0510 & (01384) 244420 (Russells Hall Hospital).

Physical activity in people with hip or knee osteoarthritis. A qualitative study.

(Participant consent form)

Please fill in with your initials:

1. I confirm that I have read the information sheet and have had the opportunity to discuss the study with the researcher.....
2. I confirm that I have a physician-made diagnosis of hip or knee osteoarthritis
3. I understand that my participation in this study is voluntary and that I am free to withdraw at any time up to 20 days after the interview or focus group takes place without giving any reason.....
4. I understand that the content of the interview or focus group that I will participate in will be audiotaped, but that the audiotapes will be treated and stored as strictly confidential and will be destroyed after the completion of the study.....
5. I understand that sections of my interviews will be transcribed and used to write up a doctoral dissertation and academic publications, but that confidentiality and anonymity will be maintained and it will not be possible to be identified by the quoted material.....
6. I understand that my information will be treated by the research team as strictly confidential and handled in accordance with the provisions of the Data Protection Act. In the case of focus groups, where more participants are involved, I understand that absolute confidentiality cannot be ensured.....
7. I agree to take part in the above research study

Name of participant

Date

Signature

Name of researcher

Date

Signature

If you have further questions about the study, please contact Archontissa Kanavaki at or . You may also contact the academic supervisor of this project Professor Joan L. Duda at or .

6.3 Interview Schedule (Chapter 7)

Physical activity and hip/ knee osteoarthritis- Interview schedule

OA experience and well-being

How long is it since you were diagnosed with OA?

How does it affect your life- if it does?

What is the well-being to you, how do you experience it?

(probe: emotional, cognitive, somatic/functional aspects)

On the other hand, what is ill-being to you?

Personal meaning of being physically active and being sedentary

When it comes to being **physically active** (moving or being in motion in contrast to sitting or lying), what do you do? *(details on what activities they do e.g. leisure or part/function of daily living)*

What makes these PAs a positive experience? What makes them a negative experience?

[What does it mean for your well-being and ill-being, we were discussing earlier?]

-How have you experienced physical activity in the past? *(in a similar way? Positive, negative?)*

When it comes to spending **time sitting**, or lying down, how is this in your daily life?

What makes it a positive experience? What makes them a negative experience?

1. More active individuals

You are a person who tries to be physically active *(ref to info given by the participant)*. This despite the pain and other barriers you might be experiencing.

What keeps you active?

Anything specific that you do, strategies that you follow?

How have you dealt with things that might stop you?- *example with thoughts and feelings*

Are there people who play a role in you being active? (*What do they do?*)

What do you think it means for OA? For your health in general?

What keeps you sitting?

Are there people who play a role in you being active? (*What do they do?*)

What do you think it means for OA? For your health in general?

[*Presenting research findings regarding sedentary time*] Have you tried to break up your sitting time? If yes, what helps you do this? If no, what stops you?

2. More inactive individuals

When trying to or thinking about doing physical activities how do you feel?

Could you give me an example? (*Identify feelings and thoughts related to this example*)

So you have this experience/ concerns [reflecting what the participant has mentioned] that put you off activities. On the other hand, [present research findings- PA benefits for mobility, pain, general health; positive experience and well-being reported by people who keep more active]. Yet, starting and keeping up with a more active lifestyle can be challenging, even a struggle. What do you think would get you going? Keep you going? (*individual strategies, other people's actions, conditions*)?

[*Presenting research findings regarding sedentary time*] Have you tried to break up your sitting time? If yes, what helps you do this? If no, what stops you?

6.4 Transcribed interview example: Brian

[??] = word(s) not clear

... = indicates a pause or switch of thought mid sentence

Word with (?) = indicates best guess at word

[IA] = sentence(s) inaudible or indecipherable

Participants

I = Archontissa Kanavaki, Interviewer

Brian = Interviewee

I: How long is it since you had a diagnosis?

Brian:

Brian:

[Redacted text block containing 20 horizontal lines]

I: The biggest blocker is the schedule or the...?

Brian: [Redacted text block containing 4 horizontal lines]

I:Just to go back to what you said about living with dull pain all the time. Does this affect your life in other ways?

Brian:

[Redacted text block]

I:I'll get back to this in a bit, before that I want to ask you what does wellbeing mean to you? How do you experience it?

Brian: [Redacted text block]

I:So there is a physical component which then extends to the emotional?

Brian: [Redacted text block]

[REDACTED]

I:I'm beginning to get an idea of your daily life. You say you have a job that requires a lot of sitting, so that's many hours during the day.

Brian: [REDACTED]

I:And then you go back home and you stay in and spend time with your son.

Brian: [REDACTED]

I:Then evening comes and you're with the family.

Brian: [REDACTED]

I:You mentioned in your early and late 20s you were pretty active.

Brian: [REDACTED]

I:How did that change?

Brian:

[Redacted text block containing 20 horizontal lines]

I:I guess there are many factors because you also mentioned that at some point you didn't have confidence in your knee, you were afraid it might give way.

Brian:

I: If I get it right, it sounds like being active for you is being super active.

Brian:

I:And the other side is a rather sedentary schedule, although there are many in between stages.

Brian:

I:How is one target different than the other?

Brian:

I: So those play an important role?

Brian:

I: Are there any other strong motivations that you find yourself having?

Brian:

I: It sounds like an activity at the moment.

Brian:

I: What would make him embarrassed of his dad?

Brian:

[Redacted text block]

I: I understand you're quite concerned about being healthy and being the dad you want to be for him.

Brian: [Redacted]

I: I was wondering whether it's like a pressure, because you say that these dads are so fit and play football and that your friends' dads used to be like this, it's as if you should be like this.

Brian: [Redacted]

I: Or it's not good enough or...

Brian:

I: These activities that you do per day, I guess the more active part is when you play with your son, when you do other activities together or as a whole family, or when you go for your walk.

Brian:

I: Are any of these positive experiences?

Brian:

[Redacted text block]

I: So what would be your daily target? If we can come down to an example besides your general target to be more active and put it in your daily life, can you give me an example of a daily target that you had and it didn't work as you wanted?

Brian: [Redacted text block]

I: Is this a plan that you were happy with?

Brian: [Redacted text block]

I: If you go back to one evening, let's say last week, can you think of an evening when this happened?

Brian:

I: Why not?

Brian:

I: So there is a voice that says you should be doing it regularly?

Brian:

I: What does it mean? Why is it so bad not to do it regularly?

Brian:

I:It does. Are there other alternative plans that you could have? I understand scheduling a gym regularly is rather difficult and you do want to spend time with your family. I was wondering if you could plan something together within the house or other plans.

Brian:

I: Any strategies that you could think of that would help you along the way?

Brian:

I: Do you feel that the way you experience the relationship with being active, more or less, do you feel that this is how most people in your situation would experience it?

Brian:

I:Are there other ways in which not doing is a positive experience other than avoiding the worry about the knee?

Brian:

I:How did that feel?

Brian:

I:The fact that you realised that you can do it.

Brian:

I: It was important to have a positive experience?

Brian:

I: One last question, what advice could you give to people who are in the same situation and would like to be more active?

Brian:

[REDACTED]

I.Sounds like a very good piece of advice.

Brian: [REDACTED]

Recording ends 49:26 minutes

