

**THE ASSOCIATION BETWEEN MUSCULOSKELETAL PAIN AND PHYSICAL
ACTIVITY, FALLS AND PSYCHOLOGICAL CONCERNS RELATED TO FALLS
IN COMMUNITY DWELLING OLDER ADULTS**

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**A thesis submitted in partial fulfilment of the requirements of the University of Greenwich for
the degree Doctor of Philosophy**

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DECLARATION

I certify that this work has not been accepted in substance for any degree, and is not concurrently being submitted for any degree other than that of Doctor of Philosophy being studied at the University of Greenwich. I also declare that this work is the result of my own investigations except where otherwise identified by references and that I have not plagiarised the work of others.

Signatures

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Finally, thank you to the lady (whose name I do not know) who brought me a message of hope on a hazy day in early 2010 when the sun was not shining too brightly and said '*Forget the former things; do not dwell on the past. See, I am doing a new thing! Now it springs up; do you not perceive it?*'

ABSTRACT

Abstract

Background

Chronic musculoskeletal pain (CMP) is a common pervasive issue among older adults and may affect mobility and falls risk.

Aims

Investigate the relationship between CMP and physical activity/ sedentary behaviour, psychological concerns related to falls and falls in community dwelling older adults.

Method

A mixed method sequential explanatory approach was adopted, informed by three systematic reviews. Five quantitative studies were devised and community dwelling older adults were recruited across 10 sites in London. CMP was assessed and standardised information regarding falls, psychological concerns related to falls, sedentary behaviour and confounding factors collected. A convenience sample of 20 participants with CMP were recruited exploring the three phenomenon using semi structured interviews.

Results

Overall, 295 participants participated in the quantitative studies (77.5±8.1 years, 66.4% female) and 52% had CMP (154/295). The first results paper demonstrated that older adults with CMP were more sedentary than those without CMP (11.5 hours vs 7.9, $p<.001$). The second results study elucidated that older adults with multisite CMP are at greatest risk of recurrent falls (odds ratio 2.25, 95% confidence interval: 1.03-4.88) and that the brief pain inventory (BPI) demonstrates promising discriminative ability. The third and fourth results

studies demonstrated that high pain interference, pain severity and multisite pain were associated with increased concerns regarding falling (particularly lower balance confidence). The final quantitative results chapter demonstrated that collectively these mobility limitations and falls risk factors are significantly associated with lower health related quality of life in those with CMP. The qualitative study suggests that these relationships may not be that straight forward with few participants directly attributing pain as a cause of falls or increased concerns about falling.

Conclusion

Older adults with CMP are significantly more likely to experience falls, be more sedentary and have heightened psychological concerns related to falls compared to those without CMP.

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12. Consequences of Falling and Modified version survey of activities and FOF in the elderly scales (used with permission from Prof Yardley).

Published research papers published prospectively with the PhD

13. **Stubbs B**, Binnekade T, Eggermont L, Sepehry AA, Patchay S, Schofield P. (2014). Pain and the risk for falls in community-dwelling older adults: systematic review and meta-analysis. *Archives of Physical Medicine and Rehabilitation*. Jan;95(1):175-187.
14. **Stubbs B**, Binnekade TT, Soundy A, Schofield P, Huijnen IP, Eggermont LH. (2013). Are older adults with chronic musculoskeletal pain less active than older adults without pain? A systematic review and meta-analysis. *Pain Medicine*. Sep;14(9):1316-31.

15. **Stubbs B**, West E, Patchay S, Schofield P. (2014). Is there a relationship between pain and psychological concerns related to falling in community dwelling older adults? A systematic review. *Disability and Rehabilitation*; 36(23):1931-42
16. **Stubbs B**, Schofield P, Binnekade T, Patchay S, Sepehry A, Eggermont L. (2014). Pain is associated with recurrent falls in community-dwelling older adults: evidence from a systematic review and meta-analysis. *Pain Medicine*. Jul;15(7):1115-28.
17. **Stubbs B**, Patchay S, Soundy A, Schofield P. (2014). The Avoidance of Activities due to Fear of Falling Contributes to Sedentary Behavior among Community-Dwelling Older Adults with Chronic Musculoskeletal Pain: A Multisite Observational Study. *Pain Medicine*. Nov;15(11):1861-71.
18. **Stubbs B**, Eggermont L, Patchay S, Schofield P. (2014). Older adults with chronic musculoskeletal pain are at increased risk of recurrent falls and the brief pain inventory could help identify those most at risk. In press in *Geriatrics and Gerontology International*. 2014 Aug 28.
19. **Stubbs B**, Eggermont LH, Patchay S, Schofield PA. (2014). Pain interference is associated with psychological concerns related to falls in community-dwelling older adults: multisite observational study. *Physical Therapy*. 2014 Oct;94(10):1410-20.
20. **Stubbs B**, Schofield P, Patchay S. (2015). Mobility Limitations and Fall-Related Factors Contribute to the Reduced Health-Related Quality of Life in Older Adults With Chronic Musculoskeletal Pain. In press in *Pain Practice*.
21. **Stubbs B**, Schofield P, Patchay S, Leveille S. (2015). Musculoskeletal pain characteristics associated with lower balance confidence in community dwelling older adults. In press in *Physiotherapy*.

ABBREVIATIONS

ABC= Activities balance confidence scale

ADL = Activities of daily living

AUC= Area under the curve

BMI = Body mass index

BPAQ = Baecke Physical Activity Questionnaire

BPI= Brief pain inventory

CI= Confidence Interval

CLBP= Chronic low back pain

COPD = Chronic obstructive pulmonary disease

COF= Consequences of falling

CMP=Chronic musculoskeletal pain

EIC= Editor in Chief

EQ-5D-5L= EuroQol quality of life measure

FES= Falls efficacy scale

FES-I= Falls efficacy scale International

FG=Focus group

FHEQ= framework for higher education qualifications

FOF= Fear of falling

FRAT-UP-Falls risk assessment tool updated

HR= Hazard ratio

HRQOL = Health related quality of life

IPAQ-SF = International physical activity questionnaire, short form

MCI= Mild cognitive impairment

MSAFFE = Modified version survey of activities and FOF in the elderly

NOS = Newcastle Ottawa Scale

OA= osteoarthritis

PASE = Physical Activity Scale for the Elderly

PPI= Participant and public involvement

PRISMA = Preferred reporting items for systematic reviews and meta-analyses

QOL=Quality of life

RCT= Randomised control trial

REF=Research excellence framework

ROC= receiver operator curve

RR= Relative risk

SAFFE= Survey of activities and FOF in the elderly

SMD = Standardised mean difference

STROBE = Strengthening the Reporting of Observational studies in Epidemiology

TUG = Timed up and go

UK= United Kingdom

VIF= Variation inflation factor

WHO=World health organisation

YLD=Years lived with disability.

DISSEMINATION OF THE PhD

Publications in international peer review journals indexed on PubMed (all in appendix in PDF published format):

Systematic reviews from literature review chapters

1. **Stubbs B**, Binnekade T, Eggermont L, Sepehry AA, Patchay S, Schofield P. (2014). Pain and the risk for falls in community-dwelling older adults: systematic review and meta-analysis. *Archives of Physical Medicine and Rehabilitation*. Jan;95(1):175-187.
2. **Stubbs B**, Binnekade TT, Soundy A, Schofield P, Huijnen IP, Eggermont LH. (2013). Are older adults with chronic musculoskeletal pain less active than older adults without pain? A systematic review and meta-analysis. *Pain Medicine*. Sep;14(9):1316-31.
3. **Stubbs B**, West E, Patchay S, Schofield P. (2014). Is there a relationship between pain and psychological concerns related to falling in community dwelling older adults? A systematic review. *Disability and Rehabilitation*; 36(23):1931-42
4. **Stubbs B**, Schofield P, Binnekade T, Patchay S, Sepehry A, Eggermont L. (2014). Pain is associated with recurrent falls in community-dwelling older adults: evidence from a systematic review and meta-analysis. *Pain Medicine*. Jul;15(7):1115-28.

Results papers

5. **Stubbs B**, Patchay S, Soundy A, Schofield P. (2014). The Avoidance of Activities due to Fear of Falling Contributes to Sedentary Behavior among Community-Dwelling Older Adults with Chronic Musculoskeletal Pain: A Multisite Observational Study. *Pain Medicine*. Nov;15(11):1861-71.
6. **Stubbs B**, Eggermont L, Patchay S, Schofield P. (2014). Older adults with chronic musculoskeletal pain are at increased risk of recurrent falls and the brief pain inventory

could help identify those most at risk. In press in *Geriatrics and Gerontology International*. 2014 Aug 28.

7. **Stubbs B**, Eggermont LH, Patchay S, Schofield PA. (2014). Pain interference is associated with psychological concerns related to falls in community-dwelling older adults: multisite observational study. *Physical Therapy*. 2014 Oct;94(10):1410-20.
8. **Stubbs B**, Schofield P, Patchay S. (2015). Mobility Limitations and Fall-Related Factors Contribute to the Reduced Health-Related Quality of Life in Older Adults With Chronic Musculoskeletal Pain. In press in *Pain Practice*.
9. **Stubbs, B.**, Schofield, P., Patchay, S., Leveille, S. (2015). Musculoskeletal pain characteristics associated with lower balance confidence in community dwelling older adults. In press in *Physiotherapy*.
10. **Stubbs, B.** Patchay, S., Schofield, P. “Since I had the falls I am much more careful.....I won’t let it defeat me” A qualitative study investigating older adults with chronic pain experiences of falls, psychological concerns related to falling and physical activity. Submitted.

Oral Research Presentations

1. Is pain an important risk factor for falls? How can we identify those with pain most at risk of falling? 33rd Physiotherapy Research Society Conference. 14th May 2014, University of East Anglia, Norwich, UK.
2. Can the brief pain inventory help identify older adults who are most at risk of falling? Chartered Society of Physiotherapy annual Conference October 10-11th 2014, National Indoor Arena, Birmingham, UK.

Poster Presentations

1. British Geriatrics Society Falls conference September 2012. Bristol – pain and falls meta-analysis.

Presentation to Non-academic audiences

1. Considering pain as a risk factor for falls and practical ways to identify older adults most at risk of falling in the community. Presentation to Greenwich community falls service August 2013, Greenwich, UK.

IMPACT AND WIDER ESTEEM STATEMENT

The recent research excellence framework (REF 2014) stressed the importance that research should seek to have an impact outside the researcher's academic institution. In particular research should seek to demonstrate a positive influence on the wider society including influencing other research, policy, the economy and the wider quality of life of people (REF 2014). Therefore, the impact and wider esteem that stems from this thesis will be summarised concisely below, represented by impact on: (a) research, (b) clinical practice, and (c) raising awareness among clinicians and the public.

International impact and recognition of the research

1. Collectively, the 9 published papers from the research generated within the thesis have been cited in over 60 peer reviewed research papers from authors across the world. This illustrates that the research is already being utilised by the international research community.
2. The multicountry 4,578,505 Euros, European Commission funded 'Farseeing' project, has developed and validated a new falls risk assessment tool (FRAT-UP) and included pain as a risk factor for the first time (1). The authors cite the publication generated (2) from the literature review within Chapter 4 as evidence for including pain in their new FRAT-UP tool. The FRAT-UP will be utilised in many countries across Europe.
3. The fourth literature review chapter containing the first meta-analysis to establish an association between pain and falls (2) was entered into the REF 2014 for the University of Greenwich in recognition of its quality. Specifically, in the pre-REF preparation, an independent report and analysis from an international expert deemed the paper to be one of a handful of 4* quality publications across the Faculty of Education and Health in the University of Greenwich (see appendix for independent report).

Influencing practice of falls prevention locally

Following the presentation of the meta-analysis contained within Chapter 4 (2) to the local community falls service, the team updated their falls risk assessment and now include the brief pain inventory. Thus, the research has had an impact on clinical practice and influenced the care of local people who are at risk of falling or who have fallen. An acknowledgement letter from the manager at the local community falls service is attached in the appendix (see appendix).

Influencing national clinical practice

1. The findings of the published literature review chapter (2) demonstrating that older adults with pain were more likely to fall, were highlighted as being research of particular importance by the research editor at Frontline magazine, a fortnightly magazine that goes out to all 52,000 physiotherapists in the UK. The research was summarised in the November 2013 edition (for details please see <http://www.csp.org.uk/frontline/article/physio-findings-older-people>).

Raising the awareness internationally among clinicians and the public

In December 2013, Professor Lorimer Moseley's prestigious research group 'Body in Mind', approached the researcher to write a blog to highlighting the findings from the literature review chapter that established a relationship between pain and falls (2). Details of this blog can be found at <http://www.bodyinmind.org/pain-as-a-risk-factor-for-falls/>

Also, Chapter 8 was selected and summarised as a news story for the website Pain Toolkit (see

<http://www.pain toolkit.org/search/6e17fa0adc7f681c8a6b406278b2e310/news/news/news/art>

[icleolder-adults-with-chronic-musculoskeletal-pain-are-at-increased-risk-of-rec](#)). The pain toolkit is distributed to several thousand people living with chronic pain and healthcare professionals across the world.

Finally, according to scopus the 9 articles published for the thesis have been disseminated to over 100,000 people globally through various social media outlets and blogs.

CHAPTER 1 INTRODUCTION

1.1 Introduction

The Ageing population

We are currently experiencing unprecedented global demographic changes as life expectancy continues to rise whilst at the same time the number of years lived with disability (YLD) is also rising (1, 2). This observation is also evident locally in the United Kingdom (UK), where between 1990 and 2010 the average life expectancy rose by 4.2 years whilst the number of YLD also increased (1). It is becoming evident that despite progress in reducing mortality rates across the world, relatively little impact has been made in reducing the prevalence and burden of chronic diseases on the health of people across the world (3). This poses an incredible challenge for health and social care systems across the world (1) and in the UK, where the population of the 65-84 year olds and the over 85's is expected to increase by 39% and 106% respectively between 2012 and 2032 (4).

Leading cause of disability: Chronic musculoskeletal disorders and pain

The recent Lancet global burden of disease series, demonstrated that chronic musculoskeletal disorders, such as osteoarthritis and chronic low back pain (CLBP) are leading global contributors to YLD (2). In the UK, chronic musculoskeletal disorders remain the leading cause of YLD accounting for approximately 30.5% of the total burden (1). Given this, the prevention and management of chronic musculoskeletal disorders is becoming increasingly important and healthcare systems must respond to address this mounting challenge. One of the primary symptoms of chronic musculoskeletal disorders is pain (5). To this end, chronic musculoskeletal pain (CMP) remains one of the most common reasons that people seek medical help (6). The financial impact of CMP is also profound. For instance, in 2010 it was

estimated that the costs associated with chronic pain in the United States were between 560 to 635 billion dollars per annum (7). Unsurprisingly, CMP is associated with high costs across Europe and in the UK (8, 9).

Chronic musculoskeletal pain definition and epidemiology

Whilst numerous definitions exist, the international association for the study of pain (IASP) define pain as “*an unpleasant sensory and emotional experience associated with actual or potential damage or described in terms of such damage*” (10). More specifically, CMP has been defined as pain lasting for the past month and for at least three of the previous 12 months (11). CMP is particularly common and pervasive in older adults (12, 13) defined by the World Health Organisation (WHO) as those who are 60 years or older (14). Whilst ascertaining the exact prevalence estimate of CMP in older adults is challenging due to the heterogeneity in the use of outcome measures, definitions and variations seen in different settings, it is estimated that approximately 50% are affected, although, it could be as high as 93% (13). Indeed, a recent nationally representative cohort study equating to over 35 million older adults in the United States (US), established that 52.9% reported experiencing troublesome pain over the past month (15). The most common sites of CMP are the back, neck and lower limbs (13). However, CMP is often not isolated in one region of the body and many older adults experience CMP across two or more sites (multisite pain, (15)). From the literature it appears that both the intensity and prevalence of pain increases with age and females typically report higher levels (16).

The burden of CMP in older adults

Research regarding the deleterious impact of CMP on the health and wellbeing of older adults is unequivocal and continues to expand and unfold. The array of the adverse effects of CMP in older age are diverse and include increased levels of depressive symptoms (17), difficulties

with sleep (18, 19) and reduced quality of life (QOL, (20)). In particular, higher pain severity and multisite pain appear to have a pronounced negative impact on the outcomes in each of these domains (17, 19, 20). More recently, research has started to consider the impact of CMP on mobility limitations such as reduced balance and difficulties undertaking activities of daily living (ADL). For instance, pioneering work from Leveille et al (21, 22) demonstrated that musculoskeletal pain and in particular multisite CMP, is an independent predictor for the future development of disability in older adults. More recently, a study (23) demonstrated over 5.6 years that after controlling for age, sex and education, older adults with CMP risk of developing ADL disability increased 20% for each additional pain site (Hazard ratio (HR) 1.20, 95% CI 1.11-1.31). Moreover, the authors (23) established this relationship remained robust after controlling for several potential confounding variables including body mass index (BMI), physical activity, cognition, depressive symptoms and vascular diseases. Utilising the Boston Mobilize population cohort dataset, Eggermont et al (24) established that multisite CMP is a predictor for the development of disability over 18 months (Relative risk (RR) = 2.95, 95% CI 1.58–5.50) and that a stronger relationship is observed with multisite pain causing interference as opposed to pain severity.

The impact of CMP on fall risk and related factors

Given the potential for the development of future disability among older adults with CMP, more recently, research has started to investigate the impact of CMP on fall related factors and mobility outcomes. More specifically, research has begun to focus on the impact of CMP and reduced functional mobility, balance and alterations in gait (25) which may influence an older adult's activity levels due to both fear of exacerbating pain symptoms and heightened concerns about falling over (16). Such limitations in physical activity may lead to sensorimotor deconditioning and, potentially, increase an older adult's risk of falls and a vicious cycle which may in the longer term also increase the development of disability (21,

22). However, although a plausible theoretical link can be postulated regarding the impact of CMP on physical activity, falls risk and heightened concerns about falling over, very little is actually understood about the influence of CMP on these important outcomes. Clearly, research is required to better understand these relationships.

At the start of enrolment for this thesis, there was a small but growing amount of literature considering the mobility outcomes among older adults with CMP. The three mobility and fall related factors of particular interest included:

- 1) Physical activity and sedentary behaviour
- 2) Psychological concerns related to falls
- 3) Falls.

Despite widespread international acknowledgement of the importance of these 3 factors in the general older adult population (briefly explored below), few appeared to have considered the impact of these in older adults with CMP. The importance and significance of each of these phenomena will be briefly explored in order to set the tone and justification for investigating these within the PhD. In the ensuing section, each of these 3 phenomena will first be explored by an introduction, elucidating why each phenomenon is important for older adults with reference to the literature. Secondly, each phenomenon will be explored in relation to CMP thus setting the scene why it may be an issue of particular important in older adults with CMP.

Physical activity and sedentary behaviour and chronic musculoskeletal pain

The importance of physical activity and sedentary behaviour

Physical activity is defined as ‘*any bodily movement produced by skeletal muscles that results in energy expenditure*’ (page 85 (26)). There is a growing body of literature demonstrating that physical activity is effective in preventing cardiovascular disease (27), diabetes (28), cancer and depression in older adults (29). In addition, there is increasing recognition that physical activity is essential to prevent the onset of cognitive impairment including dementia (30). Consequently, there is an increasing emphasis on the promotion of physical activity as a central component to healthy ageing (12, 31). In recognition of the importance of physical activity for health and wellbeing, numerous national (32) and international (33) health organisations have developed physical activity targets for older adults.

At the opposite end of the continuum from physical activity, interest has grown regarding sedentary behaviour which refers to behaviours such as sitting, lying down, and reclining during waking hours that do not increase energy expenditure substantially above an individual’s basal metabolic rate (34). Indeed, physical inactivity is the 4th leading cause of avoidable global mortality and has become a major focus for public health organisations (33). There is emerging evidence that excessive sedentary behaviour is associated with a range of deleterious outcomes independent of the amount of physical activity that an individual engages in (28, 35). This is exemplified in a recent meta-analysis (35) which demonstrated in the general population that higher levels of sedentary behaviour are associated with higher levels of all-cause mortality (HR 1.24 [95% CI, 1.09 to 1.41]), cardiovascular disease mortality (HR, 1.17 [CI, 1.10 to 1.25]), cardiovascular disease incidence (HR, 1.14 [CI, 1.00 to 1.72]), cancer mortality (HR, 1.17 [CI, 1.10 to 1.24]), cancer incidence (HR, 1.13 [CI, 1.05 to 1.21]), and type 2 diabetes incidence (HR, 1.91 [CI, 1.64 to 2.22]). Given the aforementioned, both increasing physical activity and lowering levels of sedentary behaviour

are clearly important contributing factors to healthy ageing and wellbeing and there is good reason to suspect that these may be influenced in older adults with CMP.

Why physical activity and sedentary behaviour may be important issues for older adults with CMP?

Despite the realisation of the importance of physical activity and sedentary behaviour and their influence on health outcomes in older adults, little is known about these in older adults with CMP. In fact, to date most research investigating physical activity and CMP has considered younger adults (<60 years, (36)). However, the importance of physical activity and issues regarding excessive sedentary behaviour cannot be understated, since large population studies have established that higher levels of physical activity are associated with a lower incidence of chronic musculoskeletal disorders (37). In addition, physical inactivity has been linked to the onset of CMP (38). Moreover, physical activity is advocated as a frontline non-pharmacological intervention to manage CMP (13). Specifically physical activity may help to modulate pain and negate its intensity (36) and exercise (structured physical activity) is particularly effective in reducing pain and disability among people with chronic musculoskeletal disorders (39). Given this, it is surprising that so little is actually known about physical activity in older adults with CMP. Much in line with the delay in interest within the general older adult population, there is a particular paucity of research considering sedentary behaviour in older adults with CMP. Given the robust evidence demonstrating the independent deleterious impact of sedentary behaviour on health, research is specifically required to address this in older adults with CMP.

Given the aforementioned, research is required to understand whether older adults with CMP engage in less physical activity and are more sedentary, as well as to identify what factors

may influence these. In addition, research is required to understand how concerns regarding falling and actual falls risk, may influence physical activity and sedentary behaviour.

Psychological concerns related to falls and older adults with chronic musculoskeletal pain

The importance of psychological concerns related to falls

Psychological concerns related to falling is an umbrella term to depict the numerous facets of concerns that may arise regarding falling over (40). The four most common psychological concerns related to falls include fear of falling (FOF), avoidance of activities due to FOF, falls efficacy and balance confidence (41). Research in the general older adult population has demonstrated each of these can have a profound impact on an older adult's health and wellbeing, particularly when these are disproportionate to the actual physiological risk of falling (42, 43). For instance, although restricting ones physical activity due to an actual increased risk of falling may in the short term prove functional, when this is disproportionate to a person's physical capabilities, it can result in sensorimotor deconditioning, reduced balance and actually increase a person's risk of falls (40, 44). In addition, avoiding activities due to concerns related to falling can increase social isolation, reduce quality of life and is associated with depressive symptomology (44, 45). Psychological concerns related to falls are very common in the general community dwelling older adult population, affecting up to 85% (46). Initially FOF was referred to as a post fall syndrome, but there is increasing evidence that psychological concerns are highly prevalent among people that have not fallen. For instance, in a large population cohort study (47) (n=926) found that 70% of older adults who reported FOF did not have a history of falls within the previous year. Whilst psychological concerns related to falls have received considerable attention within the general medical literature (43), few studies have considered this among older adults with CMP despite the high prevalence and shared risk factors.

Why might psychological concerns related to falls be an important issue in older adults with CMP?

One possible mechanism by which older adults with CMP may be less active and more sedentary could be due to higher levels of avoidance of physical activity attributed to a FOF or reduced balance confidence. In the chronic pain literature, the avoidance of physical activity due to a fear of injury/ pain has widely been considered for some time within the fear avoidance model (48). In the general older adult literature, the avoidance of physical activity due to psychological concerns related to falling has received considerable attention (49) (50). Given the relationship between pain with mobility limitations (25, 51) and progression to disability (22), it seems likely that CMP may cause increased concerns about falling. This could potentially be one reason why older adults may avoid activities (becoming more sedentary), which may in time lead to reduced functional mobility and increased falls risk. However, this clearly requires investigation in order to attempt to disentangle these potential relationships.

Despite the high prevalence of psychological concerns related to falling and their impact on the health and functioning of older adults, the association with CMP is not clear and few authors have directly considered this. It is possible that psychological concerns related to falls may be associated with decreased physical activity, increased sedentary behaviour and also with risk of actual falls in this population and it therefore warrants further investigation.

Falls and chronic musculoskeletal pain

Why are falls an important issue?

Falls are a leading cause of morbidity, hospitalisation, admission to long term care facilities and mortality among older adults across the world (52). Moreover, falls can have a drastic impact on an individual's quality of life and may result in marked changes to an individual's social functioning (53). In addition, falls are very costly to health and social care systems across the world (54). Falls are also relatively common and each year round 30% of older adults will fall and 15% will experience recurrent falls (fall two or more times; (55)). A fall is defined as '*an unexpected event in which the participants come to rest on the ground, floor, or lower level*' (56). Due to the high levels of injury, reduced functioning and other adverse events, preventing falls is a national (57) and international priority (52). A key strategy to achieve the prevention of falls is the identification and management of risk factors (55, 58). Indeed, multifactorial falls prevention interventions rely upon the necessary identification and management of risk factors in order to be successful (59). Within the last decade, there has been a plethora of epidemiological research attempting to better understand and identify falls risk factors. Surprisingly, little research has considered the impact of pain and in particular CMP as a risk factor for falls.

Why might falls be an issue among older adults with CMP?

Chronic musculoskeletal pain contributes to functional decline, muscle weakness and is associated with mobility limitations all of which could predispose an older adult to falls (15, 51, 56, 60). Due to these changes, it is reasonable to assume that CMP may increase an older adult's risk of falls. However, few authors have clearly considered this and the research to date regarding the influence of CMP on falls is inconclusive and warrants investigation. Moreover, the relationship between CMP and recurrent falls has to the author's knowledge

received virtually no attention in the literature. This is despite the fact that both national (57) and international falls prevention guidelines (61) recommend that preventing recurrent falls is of utmost priority. In fact, none of these guidelines currently recognise CMP or pain as a risk factor for falls. Thus, definitive research is required to systematically search, appraise and synthesise the literature on pain and falls in order to identify new research directions to better understand if CMP is related to falls.

1.2 Rationale for this thesis

With the rising burden of chronic musculoskeletal disorders and high levels of CMP in older adults across the world (13), the possible relationship with lower levels of physical activity and higher levels of sedentary behaviour may have profound effects not only on the development, severity and management of pain (36), but also on the wider health and wellbeing of older adults (27, 31). In addition, the societal costs of each of the phenomenon separately are profound. Whilst it may be plausible to naturally assume that older adults with CMP are less active and more sedentary, empirical investigation is required to refute or confirm this notion. In addition to establishing if overall levels of activity differ, there is a need to understand if levels of sedentary behaviour differ and if this is related to the avoidance of activities due to FOF for example. Moreover, in their own right psychological concerns related to falls are associated with multiple adverse health outcomes (43, 46) yet the association with CMP remains undetermined and largely ignored to date. Since such concerns related to falls are common in general older adult's settings (46) and there is a theoretical increased risk of older adults with CMP experiencing these factors, quantitative research is required to establish if indeed older adults with CMP are more likely to experience such phenomenon. Finally, recent research (11) has suggested that CMP may be an important risk factor for falls in community dwelling older adults. However, the research is equivocal and this warrants further quantitative investigation. This is necessary since falls are a leading cause of injury, hospitalisation and death in older adults (58, 62) and if older adults with CMP are more likely to fall, this would have a profound impact on a large number of older adults.

In summary, CMP is a common and pervasive phenomenon with profound individual and societal costs. The possible relationship with physical activity/ sedentary behaviour, psychological concerns related to falls and actual falls is important for numerous reasons, not

least because each of these phenomenon are already known to contribute to adverse health and wellbeing in older age already. Moreover, there appears to be a paucity and at best an inconclusive evidence base regarding each of these. In addition, research is required to consider the wider impact of these fall related factors and mobility limitations on quality of life of older adults with CMP. The ultimate need is to better understand these potential relationships so that future possible interventions can be developed for the large proportions of older adults with CMP across the world.

1.3 Research aims of the thesis

Given the aforementioned, three primary aims were developed for this thesis which necessitate quantitative enquiry. In addition, due to the potential for mobility limitations and fall related factors to negatively influence an older adult's quality of life, a fourth secondary, research aim was established to investigate this also employing quantitative research. Whilst quantitative research will enable statistical inferences to answer these research aims, this will be greatly enriched by qualitative investigation through a closely related secondary fifth aim to investigate personal accounts of older adults with CMP of each of these phenomena. Full details of the justification for each research approach with reference to the philosophical and scientific reasons are given in chapters 5 and 6 respectively.

The specific aims of the thesis are:

Primary aim 1: To determine if older adults with CMP engage in less physical activity and more sedentary behaviour than older adults without CMP (Chapters 2 and 7).

Primary aim 2: To determine the relationship between musculoskeletal pain characteristics and psychological concerns related to falls in older adults (Chapters 3, 9 and 10).

Primary aim 3: To establish if older adults with CMP are more likely to fall than older adults without CMP (Chapters 4 and 8).

Secondary aim 4: To investigate the impact of mobility limitations and fall related factors on the health related quality of life of individuals with CMP (chapter 11).

Secondary aim 5: To explore older adults with CMP experiences of falls, psychological concerns related to falls and physical activity in a purpose sample (chapter 12).

Mixed Method approach

Given the need for methodological diversity to achieve these aims, a mixed methods sequential explanatory design was developed. This approach enables the author to utilise both quantitative and qualitative research methods, thus reducing the limitations of each whilst also taking advantage of their own respective strengths (63-65). Full details of the methodological approach taken together with a critical discussion are presented in chapter 5.

1.4 Overview of the thesis structure

The importance of embedding research on the findings of systematic reviews

The bedrock for the design of the primary data collection for the PhD was devised and developed based upon new knowledge acquired through comprehensive systematic reviews and appraisal of the literature in each of the three key areas (CMP and physical activity/sedentary behaviour, psychological concerns related to falls and falls). Systematic reviews (including those with meta-analyses) are the cornerstone of evidence based medicine and considered the top of the hierarchy of evidence (66). A systematic review can be defined as *‘a high-level overview of primary research on a particular research question that tries to identify, select, synthesize and appraise all high quality research evidence relevant to that question in order to answer it’* (66). The importance of conducting a systematic review is essential when undertaking research in a new area. This point is exemplified by Chalmers (67) who recently stated in the Lancet that *‘To embark on research without reviewing systematically evidence of what is already known, particularly when the research involves people or animals, is unethical, unscientific, and wasteful’* (page 1903). Given this, a decision was made to ensure that a systematic review and appraisal of the available literature was made in each of the key areas before the finer details for the research methods for the results chapters were finalised.

Moreover, systematic reviews of the literature are also valuable primary research in their own right and regarded by many as original pieces of work. This point is exemplified by a recent study (68) which surveyed the editors in chief (EIC) at the top 118 clinical journals within the National Library of Medicine (US), where 71% of the EIC confirmed that they regard systematic reviews as original primary research when combined with a Meta-analysis.

Therefore, it was the intention when homogeneity was evident, that meta-analyses would be applied to the literature acquired through systematic reviews.

Adopting a prospective publishing approach to disseminate research findings

From the outset of the registration for the PhD, a decision was made to prospectively publish new knowledge derived from the PhD endeavour (including systematic review of the literature chapters and primary data papers), so that this was in the public domain as soon as possible and not delayed until the end of the thesis. This decision to publish throughout the duration of the thesis was made for several reasons. First, delays in publishing research findings have gained increasing attention as constituting bad practice and in some cases (particularly in relation to medications) may cost lives (69). A recent series in the Lancet entitled '*how to increase value and reduce waste in research*' stipulated the importance of publishing research and advised preventing delays in the dissemination of new knowledge acquired. Failure to disseminate research findings and new knowledge to other academics and clinicians can delay improvements in the quality of care and future research endeavours. Whilst there may be some understandable reasons for delays in publishing research (70) there is increasing recognition this is bad practice. Put simply, to wait and write a thesis as a whole document first and afterwards publish the findings would deprive the public of the knowledge acquired through the researcher's endeavours and delay progress being made in the areas of study.

Second, publishing research prospectively ensures that several key criteria required by the framework for higher education qualifications in England, Wales and Northern Ireland (FHEQ) necessary for a PhD to be awarded are satisfied. Namely, the FHEQ (71) stipulate that in order to merit being awarded a PhD the thesis should among other things meet these key criteria:

- *The creation and interpretation of new knowledge, through original research or other advanced scholarship, of a quality to satisfy peer review, extend the forefront of the discipline, and merit publication.*
- *A systematic acquisition and understanding of a substantial body of knowledge which is at the forefront of an academic discipline or area of professional practice*
- *The general ability to conceptualise, design and implement a project for the generation of new knowledge, applications or understanding at the forefront of the discipline.*
- *A detailed understanding of applicable techniques for research and advanced academic enquiry.*
- *Continue to undertake pure and/or applied research and development at an advanced level, contributing substantially to the development of new techniques, ideas or approaches.*
- *The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and largely autonomous initiative in complex and unpredictable situations, in professional or equivalent environments.*

Therefore, publishing the research chapters in a purposeful and transparent manner enables the researcher to ensure that they are meeting several key criteria along their PhD endeavour.

Third, publishing chapters in a logical chronological order demonstrates a clear systematic acquisition; progression and implementation of the knowledge acquired which can subsequently be accessed in leading international journals within the public domain. For instance, it is clear to see the progression from the published literature review chapters undertaken in 2013, to the development of the primary data papers that were published in 2014 and 2015. Fourth, the currency of academic discourse has since the 1600's revolved around publishing in peer review journals (72). A key component of engaging in the peer

review process is receiving feedback from other independent international experts who critically appraise ones work and are essential in establishing a reliable body of research and knowledge on any given topic. Moreover, a key requirement of the FHEQ (71) is that work stemming from the PhD should '*merit publication*'. Thus, publishing research findings in international peer review journals prepares the researcher for a career in academia at an early stage.

Given this brief summary, the merits of publishing chapters in advance of submitting the thesis are considerable. Although publishing prospectively in this manner is common in continental Europe and Australia in particular, it appears less common in the UK (73) and some may confuse this with a '*PhD awarded by publication*' or '*PhD by publication*' which is more common in the UK. However, adopting a pre-planned prospective approach such as that employed in this thesis differs from the traditional '*PhD by publication*' considerably. For instance, the approach employed within this thesis was prospective and purposeful publication of chapters from the outset of PhD registration (i.e. a systematic progression). This is in stark contrast to the PhD by publication where in most UK institutions a number of related published papers (usually between 3 and 5) are submitted retrospectively and summarised by a supporting statement of usually 5,000 words (73) presenting a case why these merit the standards of a PhD. This is exemplified within the University of Greenwich guidelines on a PhD by publication, where a student registers for a PhD by publication who has already published a series of related papers and they are expected to write a summary report of 3,000 words briefly justifying how the retrospective published papers are linked and meet the criteria of a PhD. In addition, at the University of Greenwich and many other UK institutions, the PhD by publication is only available to existing staff members.

Moreover, a key feature identified by the FHEQ that PhD candidates must satisfy is the ability to demonstrate '*the qualities and transferable skills necessary for employment*

requiring the exercise of personal responsibility and largely autonomous initiative'. It was decided that taking this approach would enable the development of transferable skills required to become an autonomous researcher whilst at the same time contributing to the academic currency at the highest level. Thus, each literature review chapter was written with the sole intention of publishing it from the outset. Consequently, this informed the development of the research methods for the thesis and primary data collection. In keeping with this pragmatic approach, each results chapter was published in advance for the reasons stated above and is presented in the thesis containing its own brief introduction, research methods, results and discussion. This decision was made to reflect the realities of independent academic life and prepare for research autonomy and was preferred to writing one large standalone results chapter. Finally, although each results chapter contains its own discussion of results, a final generic discussion chapter was developed to provide a detailed overview, synthesis and appraisal of the overall findings from the thesis with reference to the wider literature. More specifics regarding the structure and content of the chapters are given below.

Overview of the chapters

The chapters within the thesis follow a logical, progressive and advanced study of the areas of interest for the PhD. A brief description of each chapter below provides some insight to the reader.

Chapter 2 - primary aim 1 literature review

Chapter 2 consists of the first systematic review and meta-analysis investigating if older adults with CMP are less active and more sedentary than older adults without CMP (primary aim 1). Understanding these relationships was integral to plan for the primary data collection.

Chapter 3 - primary aim 2 literature review

Chapter 3 presents the first published systematic review investigating the influence of pain on psychological concerns related to falls (primary aim 2). This review established that no study had at the time set out with the primary objective of investigating the relationship between CMP and musculoskeletal pain characteristics and each of the four common psychological concerns related to falling.

Chapter 4 - primary aim 3 literature review

Chapter 4 is the last of the literature review chapters and consists of the first meta-analysis investigating the relationship between pain and falls (primary aim 3). Within the systematic review, several sub group analyses were conducted investigating the influence of different pain characteristics on falls. Of particular note, the systematic review established that no author had set out with the primary aim to investigate the relationship between CMP and recurrent falls. This spurred the emphasis of the primary data study in which the first study

investigating the influence CMP and recurrent falls was borne out. At the end of chapter 4, the specific research questions and hypotheses were established for the PhD.

Chapter 5 - Methodology

Chapter 5 presents the critical journey of the researcher to set out their philosophical assumptions for the research study culminating in researcher's choice of research methods. A pragmatic mixed sequential explanatory model was chosen for the purposes of meeting the primary and secondary aims.

Chapter 6 - Research methods

Chapter 6 contains details regarding the research methods used within the PhD to inform the reader with details regarding study patient, public involvement and detail on how participants were recruited, instrumentation and data analysis. The chapter provides details regarding the generic methods used within this mixed method sequential explanatory method. Specific details regarding the instrumentations and analyses used to answer specific research questions are contained within each results chapter.

Chapter 7 - results paper

This chapter presents one of the first primary research studies to specifically investigate whether older adults with CMP are more sedentary than older adults without CMP. The chapter also considers the factors associated with sedentary behaviour in the sample with CMP.

Chapter 8 - results paper

The second results chapter presents the methods and results from the first study to investigate the relationship between CMP and recurrent falls. The study also investigated the

discriminative ability of the BPI to help clinicians identify those at most risk of falls and recurrent falls.

Chapter 9 - results paper

Chapter nine is the first primary data paper to investigate the influence of pain interference upon each of the four common psychological concerns related to falls. The literature review and previous results chapter demonstrated that pain causing interference is particularly pervasive among this population. Therefore, this chapter investigates how pain interference affects balance confidence, FOF, the avoidance of activities due to FOF and concerns about the consequences of falling over.

Chapter 10 - results paper

Given the results of the literature and previous results, chapter 10 investigates in specific detail the influence of musculoskeletal pain characteristics (number of chronic pain sites and pain severity) on balance confidence in the study sample. The chapter demonstrates that multisite and most severe pain are associated with lower balance confidence.

Chapter 11 - results paper

The findings from the literature review and previous 4 results chapters demonstrated that marked mobility limitations and fall related factors are evident among people with CMP. The current chapter specifically investigated the wider impact of these mobility limitations and falls related factors on Health related quality of life (HRQOL) in older adults with CMP (secondary aim 4).

Chapter 12 results paper

Chapter 12 consists of the qualitative component of the sequential explanatory model of the thesis (secondary aim 5). The chapter specifically considers the personal experiences of a convenience sample of older adults with CMP towards the three key phenomena of interest 1) physical activity/ sedentary behaviour, 2) psychological concerns related to falls and 3) falls. In line with the sequential explanatory model, the final results chapter was completed last and was also used as an opportunity to explore and explain the findings from the previous 5 quantitative chapters.

Chapter 13 - Discussion

The discussion chapter constitutes the final significant chapter within which the findings from throughout the thesis are critically appraised and synthesised with reference to the wider literature. The discussion chapter also contains specific detail regarding limitations and directions for future research.

Chapter 14 - Conclusion

The final chapter is the conclusion, where the bottom line findings of the thesis are briefly summarised.

1.5 Summary of chapter

The introduction chapter has given a background to the nature of the phenomena of interest within this PhD thesis and has described the primary and secondary aims. In addition, the reader has been introduced to the pragmatic and prospective publishing approach adopted to ensure that the findings within the thesis were in the public domain without unnecessary delay and in an effort to meet several key criteria required to be awarded a PhD. The next 3 chapters now contain the systematic reviews of each of the phenomena of interest in the PhD, namely physical activity/ sedentary behaviour, psychological concerns related to falls and falls in older adults with musculoskeletal pain.

CHAPTER 2

A SYSTEMATIC REVIEW AND META-ANALYSIS INVESTIGATING PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR IN OLDER ADULTS WITH CHRONIC MUSCULOSKELETAL PAIN

This chapter is based on the published paper

Stubbs B, Binnekade TT, Soundy A, Schofield P, Huijnen IP, Eggermont LH (2013). Are older adults with chronic musculoskeletal pain less active than older adults without pain? A systematic review and meta-analysis. *Pain Medicine* . Sep;14(9):1316-31.

This chapter relates to primary aim 1 of the thesis.

Overview of the chapter

There is an abundance of research establishing that physical activity has a multitude of health benefits for older adults and is integral for ‘healthy ageing’. Moreover, research has demonstrated that physical activity and exercise can help reduce pain and disability in those with CMP. Conversely emerging evidence from the general population has demonstrated that higher levels of sedentary behaviour are associated with a range of adverse outcomes independent of physical activity. It remains unclear if physical activity and sedentary behaviour levels are affected among older adults with CMP. In recognition of this, the current chapter provides a robust systematic search, identification, appraisal and synthesis on the available research investigating physical activity and sedentary behaviour levels among people with CMP. The chapter contains the first meta-analysis on the topic and guided the development of the primary data collection of the study.

2.1 Introduction

Life expectancy continues to rise across the Western world, and at the same time the number of years impacted by chronic musculoskeletal disorders that cause pain and disability is also rising (1, 3). The prevalence of CMP in the older population is high, with up to 50–60% of community-dwelling older adults reporting experience of these symptoms (13, 15). Chronic pain may lead to a range of deleterious effects, including an increased functional disability (21) and a decreased quality of life (74). Chronic pain may also result in a reduced level of physical activity, which is in contravention of key non-pharmacological management strategies for chronic pain that promote levels of physical activity (75).

Reduced levels of physical activity are seen as one of the biggest public health concerns of the twenty-first century (76, 77) and has been attributed as the fourth leading cause of avoidable global mortality by the WHO (33). Sedentary behaviour is associated with a higher risk for a multitude of chronic health conditions (31, 35) such as diabetes, cardiovascular disease, and cancer. In addition, lower levels of physical activity negatively affect the aging process due to an increased risk for physical and cognitive impairment (29-31), which may further impact an individual's quality of life (78). In older adults, physiological changes are known to occur at an accelerated rate and are linked to lower levels of physical activity (79). For instance, reduced physical activity is known to contribute to an increased risk of cardiometabolic disease, reduced bone density, and sarcopenia (80, 81). A vicious cycle may develop as such changes may necessitate an increased effort for older persons to engage in their routine daily physical activity, which may ultimately result in further reduced overall levels of physical activity (82).

Within recent years a number of studies focusing on individuals of working age have investigated whether physical activity levels differ in people with CMP and those without

CMP (36, 75). Interestingly, the levels of physical activity of persons of working age do not appear to differ greatly between those with or without pain, but it is unclear if a difference exists in older adults. This is highlighted in one recent systematic review (36), which established that significantly lower levels of physical activity were present in a small subgroup analysis of older adult participants with CLBP but not in the working age population nor in adolescent subgroups. Broadly speaking, it is well established that older adults engage in lower levels of physical activity (33), but the association with CMP is unclear.

Given these uncertainties the aim of this chapter was to undertake a systematic review to compare the levels of physical activity and sedentary behaviour between older adults with and without CMP.

2.2 Methods

This systematic review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (PRISMA) (83). The PRISMA is the gold standard method utilised to conduct systematic reviews and provides a high quality checklist (83).

Eligibility Criteria

Studies were considered for inclusion if they met the following criteria: 1) focused on older adults, participants who were 60 years or above; 2) measured daily levels of physical activity/ sedentary behaviour using a specific and validated self-report measure (e.g., Physical Activities Scale for the Elderly [PASE] (84), Baecke Physical Activity Questionnaire [BPAQ] (85), or objective physical activity measure [direct observation, accelerometry, pedometry, or doubly water labelled technique [DWT]]); 3) only objective measures of physical activity/ sedentary behaviour reported over three or more valid days were included (86); 4) Confirmed a sample with and without CMP and did not contain other types of pain (e.g., neuropathic pain); 5) CMP could be reported as a clinical diagnosis, or the duration of symptoms were confirmed through a self-report measure for at least the last month and 3 of the last 12 (11). 6) The type and design of the studies considered for inclusion were not restricted; and 7) reviews, expert opinion pieces, or PhD theses were excluded.

Information Sources

The systematic review of the literature was conducted according to the general guidance provided by Cochrane reviewer's handbook (66). Major electronic databases were searched from inception until December 2012, including the Cochrane Library, CINAHL, EBSCO, EMBASE, Medline, PubMed, and PsycINFO. Online searches of key journals were

conducted, including the “in press” sections of the European Journal of Pain, Pain, Pain Medicine, Clinical Rehabilitation, and the Clinical Journal of Pain. The reference lists of relevant recent systematic reviews were also checked.

Systematic Search Strategy

The search terms used were in the categories of population (older adults, elderly, frail), diagnosis (chronic pain, pain*, persistent pain, musculoskeletal pain, muscle pain), and outcome (physical activit*, daily activit*, daily steps, step count, sedentary behaviour, sedentary, exercise, physiotherapy, physical therapy, walking, leisure time act*, acceleromet*, actigraph, actometer, energy expenditure, metabolic equivalent, self-report). Key authors were contacted to establish if any key studies were missed or were currently being undertaken that may warrant inclusion.

If a study reported data on daily physical activity/ sedentary behaviour for a number of older adults within a study sample with mean age below 60 years old, the primary authors were contacted for the summary data for those participants 60 and above. Where studies reported physical activity/ sedentary behaviour levels in a mixed sample of chronic pain (e.g., neuropathic pain and CMP), the primary author was contacted to provide summary data for the participants with CMP. If any additional information or clarification was required from a study in order to clarify eligibility, three attempts were made to contact the authors, and if no response was received the article was excluded.

Study Selection

The researcher led the search strategy which was duplicated by a second independent person. Articles that appeared to meet the eligibility criteria were included for consideration in the full text review. The researcher completed the full text review and compiled a list of included

articles and a second independent person double checked this. Disagreements were mediated through discussion with a third individual and with reference to the original manuscript. If a study was encountered that reported the same data in different publications, the data from the study with the largest sample and/or most recent sample was used.

Data Collection

Data extraction was initially conducted by the researcher, and independently scrutinized and validated by a second person in accordance with principles of best practice in systematic reviews (83). An extraction form was developed from the literature (87), and the information sought included: study design, setting of the study, sample size, gender and age (mean, standard deviation, range), CMP assessment, mean duration of pain symptoms, location of pain, physical activity/ sedentary behaviour outcome measure, measurement of physical activity/ sedentary behaviour reference period, statistical methods, main results, and conclusions.

Methodological and Risk of Bias Assessment

The Newcastle Ottawa Scale (NOS) (88) was utilized to assess the methodological quality of included studies. The NOS was developed to assess the quality of nonrandomized controlled trials, and its content validity and reliability have been established (88). Within the NOS, studies are judged on three broad perspectives: the selection of the groups, the comparability of the groups, and the ascertainment of the outcome of interest. The NOS provides predefined scoring criteria, but some of these can be further specified for the topic of study (88). The NOS was adapted to account for age, gender, and/or comorbidity as comparability measures and the measurement of physical activity/ sedentary behaviour in the exposure category (89). The NOS provides a score out of 9, and scores of 5 and above are considered satisfactory/good and suitable to be included in a systematic review and meta-analysis (89). If

an included study reported on the psychometric properties of the physical activity/ sedentary behaviour measure, this was also recorded. The methodological assessment process was completed by the researcher and independently completed by an independent person and consensus was reached through discussion.

Summary Measures

The standardised mean difference (SMD), confidence intervals (CI) at 95%, and P value were calculated for the continuous data for each included study. The SMD is a useful (66) summary statistic that enables meta-analysis to be completed when a number of studies are measuring the same outcome (physical activity) but through a number of different measures (e.g., PASE (84), BPAQ (85)).

Data Synthesis

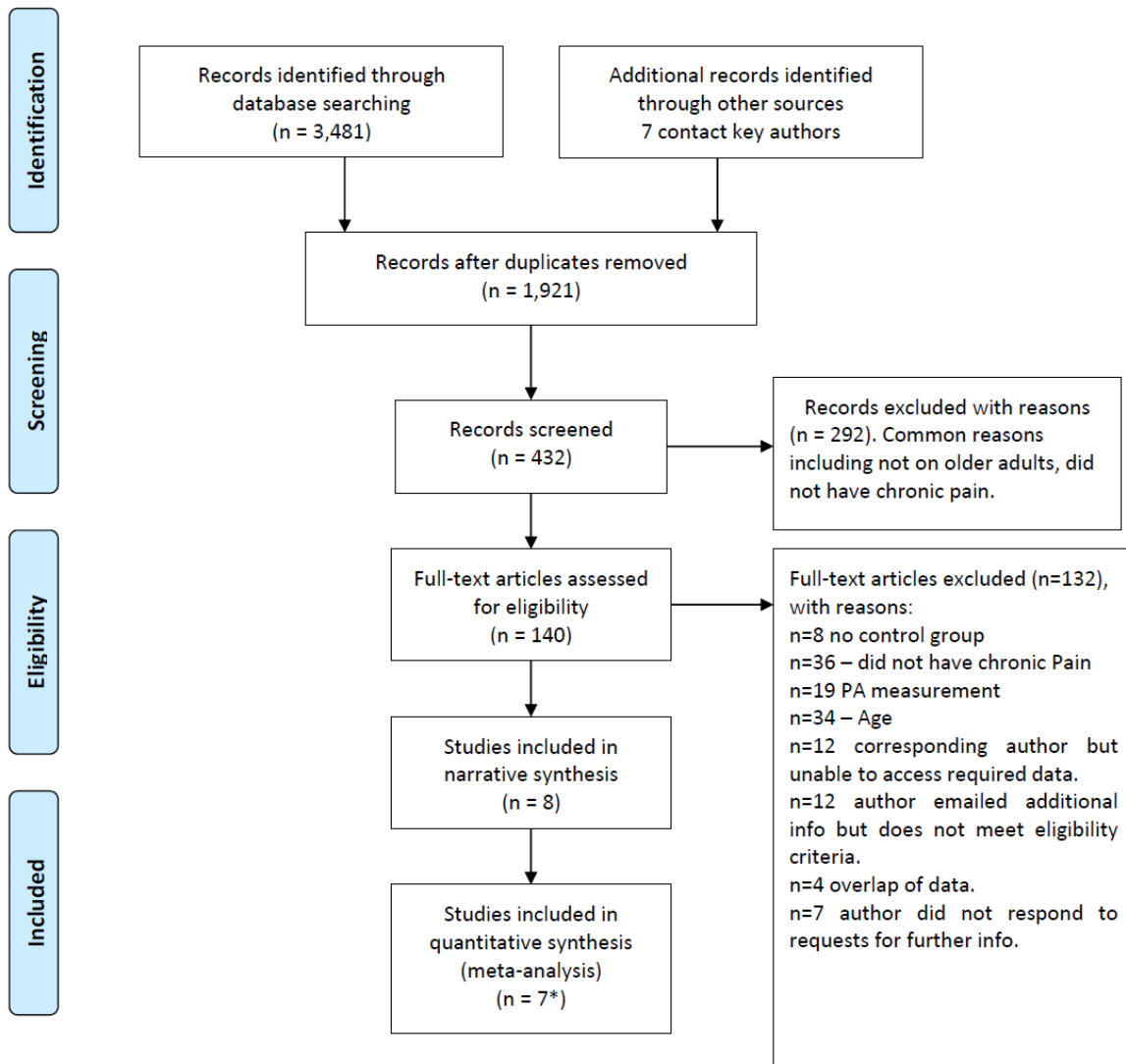
Where possible, data were pooled and a meta-analysis was performed, including subgroup analyses, to establish the influence of specific locations of pain (e.g., CLBP) on physical activity. Due to the anticipated heterogeneity of the data acquired from the scales, a random effects model was used. The random effects model provides a more conservative score than a fixed effects model as it incorporates within and between study variance. The I^2 statistic was used to measure the heterogeneity between the included studies; scores of less than 40% can be considered unimportant (66, 90). All data analysis was conducted with RevMan version 5.2.

2.3 Results

Study Selection

The original electronic search yielded a potential of 3,481 articles which was reduced to 1,921 after the removal of duplicates. The titles, key words, and abstracts of these articles were screened for eligibility, and 432 articles were identified for closer consideration, at which stage 286 were excluded and 140 articles were included in the full text review. At the full text review, 38 authors were contacted for additional information regarding their study, but 37 were consequently excluded with reasons. No study was identified that compared levels of sedentary behaviour in a sample of older adults with and without CMP. Following the full text review, a total of 132 articles were excluded with reasons (see Figure 2.1). Eight articles were included in the narrative synthesis, and seven studies were eligible for pooling in the meta-analysis. At the time of searching, no study was identified that met the eligibility criteria which measured sedentary behaviour. The search results are outlined in Figure 2.1

Figure 2.1. PRISMA 2009 flow diagram for search strategy



*Only 7 studies were eligible for pooling in the meta-analysis, a second meta-analysis was also run with 5 included studies.

Study Characteristics

A total of eight studies were included in the review accounting for 1,440 older adults with CMP and 735 controls. Seven of the included studies employed a case-control design (91-97), while one was a cohort study (98). The number of participants with chronic pain in each study ranged from 15 to 482 (94, 96). The number of participants in the control groups ranged from 15 to 274 (94, 96). The mean age of the participants with chronic pain ranged from 64.4 years of age (92) to 78.0 years (94), which was similar to the comparison group, which ranged from 64.3 years (92) to 77.6 years (94). No statistical between-group differences were reported for the comparison of age across those with and without CMP.

Four studies reported exclusively on samples of older adults with CLBP (93, 95-97), including a total of 309 participants with and 281 without CMP respectively. The other four studies (91, 92, 94, 98) included participants who had mixed sites of CMP (N = 1,186) including 488 without CMP. Of the four CLBP studies, one recruited participants directly from a chronic pain clinic, and all CLBP was attributed to either osteoporosis or a degenerative spine disorder (93). Another study (97) recruited participants from the community and primary care, and included participants with an average pain duration of 14.2 years (14.6 years), while the other two small studies included participants with CLBP of at least 6 and 12 months, respectively (95, 96). The other four studies (91, 92, 94, 98) reported on samples of chronic pain patients with mixed or unknown sites of CMP. One of these studies recruited directly from a chronic pain clinic (91), and two were large studies recruiting from the community (94, 98). The pain intensity was not available for any of the included studies.

A summary of the details of the chronic pain populations is given in Table 2.1. The information available on the asymptomatic older adult comparison group varied in each study, but almost all studies stipulated that they had to be free of CMP for at least 3 months. Three studies (93, 94, 98) were very clear that the asymptomatic group were pain-free for at least 3 months, while one stipulated that the comparison group had to be pain-free for at least 12 months (96). See table 2.1 directly below.

Table 2.1 summary of included studies

Author	Design of Study	Characteristics Participants with pain (number, mean age years \pm sd)	Characteristics Participants without pain (number, Age years \pm sd)	Chronic Pain Classification & comorbidities of chronic pain group	Physical Activity Measurement Tool, reference Period and Outcome Measure	NOS score
<i>Basler et al 2008 (93)</i>	Case Controlled Study	N=103 71.4 \pm 5.2 years 57.3% Patients from the departments of Orthopaedics and Neurosurgery of a university hospital.	N=59 71.1 \pm 4.7 years (ns) 58.0% (ns) Recruited via newspaper ads and university lectures for seniors. Pain free for 3> months	65 > years with diagnosis of CLBP due to osteoporosis or degenerative spine disorder. Exact duration of CLBP not stated.	FAQ & activity diary The FAQ measures strenuous PA and sporting activity over previous week. Re-test reliability after 6 months r =0.57- 0.45. Correlation with activity diary in study (r=0.08) FAQ scores calculated into MET h/wk	6
<i>Champagne et al 2012 (96)</i>	Case controlled Study	N=15 females with CLBP 68.9 \pm 6.6 years 100% female Community dwelling	N=15 females without CLBP 67.2 \pm 5.1 years (ns) 100% female (ns) No pain in previous year and never experienced disabling CLBP	6> months CLBP Presented tension, soreness, and/or stiffness in the lower back region with radiating pain limited to the buttocks. Chronic conditions ns between both groups.	BPAQ Authors adapted questionnaire, only asked about PA in sports and leisure time PA. PA score based on leisure and sport time domains only.	5
<i>Eggermont et al 2009 (94)</i>	Case Controlled Study	N= 482 78.0 \pm 5.3 years 62% female	N=274 77.6 \pm 4.9 years (ns) 64% female (ns) Participants in the study who on assessment had pain at no sites over the previous three months	Chronic pain >3 months confirmed via interview ¹ on at least one bodily site Categorised as: (a)Pain in one site (b) Pain in multiple sites (c) Widespread chronic pain Chronic pain group more	PASE 10 item questionnaire asking about physical activity over past 7 days A total PASE score (sum of PA in past week in domains of leisure, occupation and household) Provides measures for total number of hours spent in each	6

				likely to have OA ($p<0.001$) & RA $p=0.003$).	domain which reflects daily physical activity level	
<i>Farrell et al 1996 (91)</i>	Validation study of the Human Activity Profile (HAP) Measure ⁱⁱ for use in an elderly population	N=193 71.8 \pm 9.1 years 73% female	N=55 73.1 \pm 6.5 years (ns) 69% female (ns) Volunteers drawn from the register at National Ageing Research Institute in Australia	Consecutive older adults attending pain clinics. Mixed location of chronic pain Exact duration of pain unknown but diagnosed as chronic. Comorbidities not reported.	HAP Measure Measured at one time point Concurrent validity of AAS scores with Barthel Index spearman's correlation 0.83 ($p<0.0001$) MET/ day expressed as AAS	4
<i>Hopman Rock et al 1996 (92)</i>	Case Controlled Study	N= 59 64.4 \pm 5.5 years 75% women (n=44) All community dwelling.	N=72 64.3 \pm 5.9 years (ns) 69% female (ns) Recruitment strategy unclear but without pain & matched for age and sex with CP group. No evidence of OA on X ray.	Self-report chronic pain hip and/ or knee confirmed by study authors Duration of pain unknown 42% and 23% had radiological evidence of OA of hip and knee respectively.	PAQ Measured at one point in time but provides PA score for a typical week Validity assessed with 24 hour repeated recall of PA ($r= 0.78$) and measurement with pedometer ($r= 0.72$) Test-retest reliability $r=0.89$ PA calculated as hours per week of activity in three domains: household, sports & leisure time activities	5
<i>Ledoux et al 2012 (95)</i>	Case Controlled Study	N=29 older adults with CLBP 69 \pm 7 years 49% female Community dwelling	N=32 67.25 \pm 5.13 years (ns) 37.5% female They were without CLBP but no further information given	Classified nonspecific CLBP if had pain on at least half of the days over a 12 months period. Excluded if had OA, major spinal trauma, osteoporosis.	BPAQ 11 item questionnaire measured at one point in time provides PA score of a typical week over the last year Total Baecke score for PA over a typical week over the last year (sum of 3 subscales occupational, leisure time and sport).	4
<i>Rudy et al 2007 (97)</i>	Case Controlled	N=162 patients with CLBP	N=158	Inclusion criteria were CLBP of	PASE	6

	Study	73.6 ±5.2 years 49% female (n=80) Community dwelling	73.5 ±4.8 years (ns) 41% female (n=66) (ns) Pain free group –‘no pain or pain occurring less than once a week of little intensity	moderate intensity for > 3 months measured with Pain thermometer Average pain duration 14.2 years ±14.6. Chronic pain group had significantly more comorbidities (<i>p</i> =0.001).	Details as described above.	
<i>Woo et al 2009 (98)</i>	Cohort study	N=397 73.2 ±5.8 years 26 % men 73.0 ±5.1 years 74% women 73.2 ±5.4 years	N=70. 72.4 ±5.4 years (ns) 33% men (ns) 72.0 ±5.0 years (ns) 67% women 72.4 ±5.2 years (ns)	Had pain most of the time or all of the time over the past 12 months across a number of bodily sites	PASE Details as described above	7

Key for table 2.1: CP=Chronic Pain; CLBP=Chronic Low Back Pain; LBP =Low Back Pain; PA=physical Activity; sd=standard deviation, ns=non-significant difference, OA = osteoarthritis, RA= rheumatoid arthritis. FAQ = Freiburg Activity Questionnaire, HAP= Human Activity Profile, (99), AAS=Activity Adjusted Score, MET = Metabolic Equivalent, Physical Activity Questionnaire for the Elderly (100), BPAQ = Baecke Physical Activity Questionnaire (101), PASE= Physical Activity Scale for the Elderly (84)

Details of comorbidities in each study were generally not well reported; the available data is summarized in Table 2.1. From those studies that did report comorbidities (N = 5), the following details were provided. Champagne and colleagues (96) identified no between-group differences in chronic conditions reported. Data from another paper of the same cohort (11) established that in the MOBILIZE Boston study (94), depression; heart disease, and peripheral arterial disease were more common in the chronic pain group at baseline. Hopman-Rock and colleagues (92) established that 42% and 23% of the pain group had radiological evidence of osteoarthritis at the hip and knee, respectively, while the control group did not show this evidence. Woo et al. (98) reported that males with back pain and knee pain experienced more heart disease and chronic obstructive pulmonary disease (COPD), respectively, while all female groups with pain reported more heart disease and those with knee pain reported more COPD. Rudy and colleagues (97) found the chronic pain group had significantly more comorbidities.

Measurement of Physical Activity

All of the included studies utilized a self-report questionnaire to obtain daily levels of physical activity. The PASE and the BPAQ were used in three (94, 97, 98) and two studies, respectively (95, 96). The physical activity measurement period was frequently over the previous week (93, 94, 97), or reported as a typical week over the last year (95, 96). Only three studies reported on the reliability and the validity of the outcome measures they used in their study (91-93). The measurement of physical activity in each study is reported in Table 2.1. No study was located that measured sedentary behaviour.

Methodological quality of included Studies

The mean NOS scores for the included studies were 5.12 (± 0.83) and the summary scores are presented in Table 2.1. Six of the included studies scored a 5 or above on the NOS and were of acceptable quality (92-94, 97); two study scored 4 (91, 95).

Results of Overall Levels of Physical Activity in Daily Living in those with CMP vs Asymptomatic Older Adults

The SMD of overall level of physical activity between the chronic pain and asymptomatic groups was calculated for each study. The SMD analysis indicated that four studies reported a significantly lower level of physical activity in the older adult group with chronic pain (91, 95-97). However, the SMD effect size for differences in physical activity varied in each study quite considerably. For instance, the Rudy et al (97) study revealed an SMD of -0.29 (CI = -0.51 to -0.07), whereas Farrell and colleagues (91) established that there was an SMD of -9.81 (CI = -10.62 to -9.01). Champagne and colleagues (96) established a significantly lower level of physical activity, with an SMD of -0.96 (CI = -1.72 to -0.20), while Ledoux et al. (95) established an SMD of -1.47 (CI = -2.04 to -0.90). Four other studies (92-94, 98) all demonstrated that older adults with chronic pain were less physically active, but none of the observed differences reached statistical significance. In a sub-analysis of the Hopman-Rock et al. (92) study, the levels of physical activity within the household domain of the physical activity questionnaire were significantly reduced in the chronic pain sample (-0.42, CI = -0.77 to -0.07; $P = 0.02$). Another study (94) established that the older adults who were classified as having multiple sites of chronic pain recorded significantly reduced levels of overall physical activity compared with the asymptomatic group (-0.18, CI = -0.37 to 0.00; $P = 0.05$). The results for the individual studies are presented in Table 2.2.

Table 2.2 Results of included studies in systematic review

Author	Older adults with Chronic Pain N	Asymptomatic Older Adults (N)	Physical Activity Measure	Physical Activity Results Chronic Pain Group (Mean, SD)	Physical Activity Results Asymptomatic Group (mean, SD)	Standard Mean Difference (SMD) 95% CI	P Value
<i>Basler et al 2008 (93)</i>	103	59	FAQ	39.95 ±27.58	46.01±33.00	-0.20 (-0.52 to 0.12)	P = 0.21
<i>Champagne et al 2012 (96)</i>	15	15	BPAQ	12.4±5.4	17.5±4.9	-0.96 (-1.72 to -0.20)	P = 0.01
<i>Eggermont et al 2009 (94)</i>	482	274	PASE	104.53 + 72.06	112.5±68.88	Total : -0.11 (-0.26 to 0.04)	P = 0.14
				Pain 1 site (183) 111.99 ±82.88		Pain 1 site vs asymptomatic group: -0.01 (-0.19 to 0.18)	P = 0.94
				Pain multiple sites (190) 100.11 ±65.79*		Multiple pain sites vs asymptomatic group*6 -0.18 (-0.37 to 0.00)	P = 0.05
				Widespread chronic pain (109) 99.70±61.82		Widespread pain vs asymptomatic group: -0.19 (-0.41 to 0.03)	P = 0.09
<i>Farrell et al 1996 (91)</i>	193	55	HAP (AAS)	37.5 ± 2.1	59.1±2.5	-9.81 (-10.62 to -9.01)*	P < 0.0001
<i>Hopman Rock et al 1996 (92)</i>	59	72	PAQ	Breakdown per domain of scale: Household activities: 1.7±0.49	Breakdown per domain of scale: Household activities: 1.9±0.46*	Household activities: -0.42 (-0.77 to -0.07)*	P = 0.02
				Sports activities: 6.0±6.6	Sports activities: 6.4 ±7.2	Sports activities: -0.06 (-0.40 to 0.29)	P = 0.74

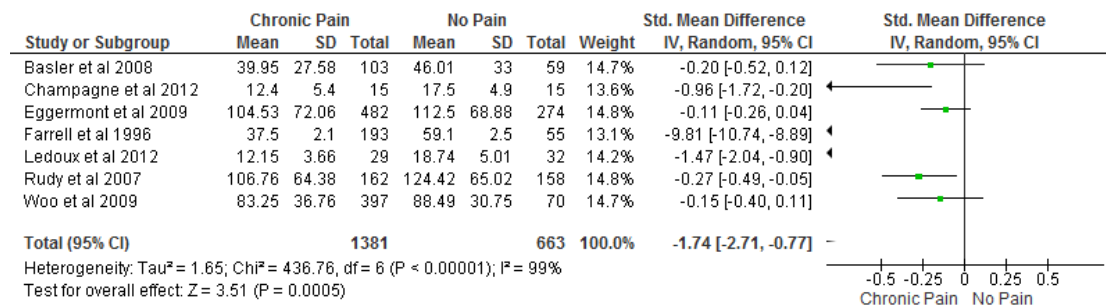
				Leisure time activities: 4.1 ±4.6	Leisure time activities: 4.4 ±5.5	Leisure time activities: -0.06 (-0.40 to 0.29)	P = 0.74
<i>Ledoux et al 2012 (95)</i>	29	32	BPAQ	12.15±3.66	18.74±5.01	-1.47 (-2.04 to -0.90)	P < 0.0001
<i>Rudy et al 2007 (97)</i>	162	158	PASE	105.76±64.38	124.42±65.02	-0.29 (-0.51 to -0.07)*	P = 0.01
<i>Woo et al 2009 (98)</i>	Total: 397	Total: 70	PASE	83.25±36.76	88.49±30.75	Total: -0.18 (-0.40 to 0.11)	P = 0.26
	104 males	23 males		83.33±45	89.3±34.52	male -0.14 (-0.59 to 0.32)	P = 0.55
	273 females	47 females		83.22±33.44	88.09±29.11	female -0.15 (-0.46 to 0.16)	P = 0.35

Key for table 2.2: CI = confidence interval; PA = physical activity; AAS = activity adjusted score. FAQ = Freiburg Activity Questionnaire., BPAQ = Baecke Physical Activity Questionnaire (101). PASE = Physical Activity Scale for the Elderly (84).HAP = Human Activity Profile (99). Physical Activity Questionnaire for the Elderly (100). Independent SMD calculation between older adults with multiple pain sites (190) vs those without pain (274) established the group with chronic pain had significantly lower levels of PA (-0.18, CI = -0.37 to 0.00, P = 0.05). *Statistically significant difference

Meta-Analysis of Included Studies

A meta-analysis was performed by pooling seven of the individual studies, and enabled comparison of physical activity levels of 1,381 older adults with chronic pain with 663 asymptomatic older adults, and is presented in Figure 2.2. One study (92) could not be included in the meta-analysis as physical activity data were available for each of the three domains, but a total score for overall physical activity was not available. The pooled SMD of overall levels of physical activity was -1.74 (CI = -2.71 to -0.77, $P < 0.00001$) indicating that older adults with CMP are significantly less active with a large effect size. The heterogeneity of the included studies as measured by the I^2 was significant and very high (99%). Two studies (91, 95) were considerable outliers in the forest plot, and the meta-analysis was recalculated in a sensitivity analysis with these studies excluded and is presented in Figure 2.3. This second meta-analysis demonstrated that the older adults with CMP (N = 1159) still had significantly reduced levels of physical activity compared with controls (N = 576), but the SMD was small (-0.20, CI = -0.34 to -0.06, $P = 0.004$). The heterogeneity of the included studies was low ($I^2=32\%$) and not significant. A subgroup meta-analysis was conducted with five studies that providing physical activity data for 641 older adults with CLBP and 334 controls. This established that the overall levels of physical activity in older adults with CLBP were moderately lower in those with CLBP (SMD = -0.52, CI = -0.87 to -0.16, $P = 0.004$). The studies were heterogeneous ($I^2 = 80\%$, $P > 0.001$). Consequently, one potential outlier was removed (95) in a sensitivity analysis and the updated analysis found that older adults with CLBP were less active than the controls, and the effect was small but significant and not heterogeneous (SMD = -0.27, CI = -0.44 to -0.10, $P = 0.002$, $I^2 = 20\%$, $P = 0.29$). The two meta-analyses for older adults with CLBP are displayed in Figure 2.4 and 2.5.

Figure 2.2 - Meta-analysis investigating differences in physical activity with all 7 studies (total n=2044)



Footnote-Due to large effect size, the summary plot is off the scale above but the total effect size is clearly displayed above (-1.74 [-2.71,-0.77]).

Figure 2.3 - Meta-analysis investigating differences in physical activity with two studies removed (91, 95) (total n = 1735)

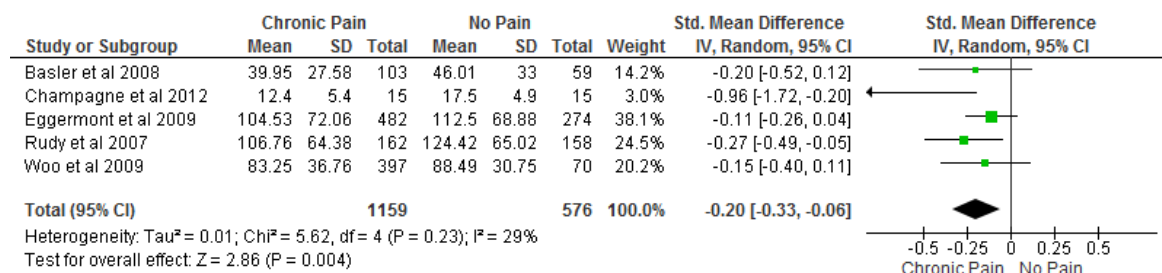


Figure 2.4 Meta-analysis investigating differences in physical activity among those with Chronic low back pain and controls (total n = 975)

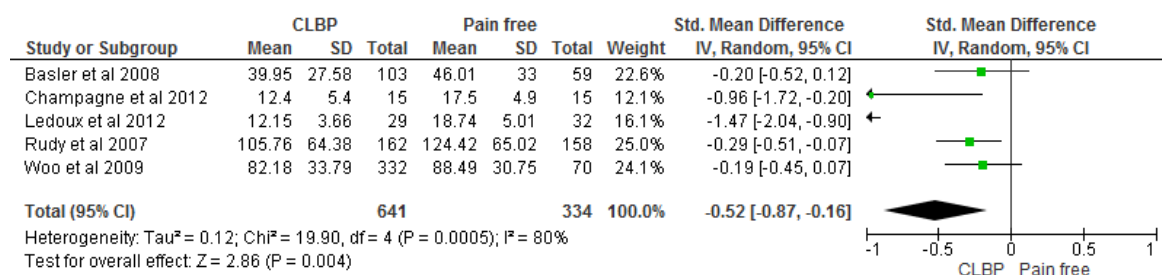
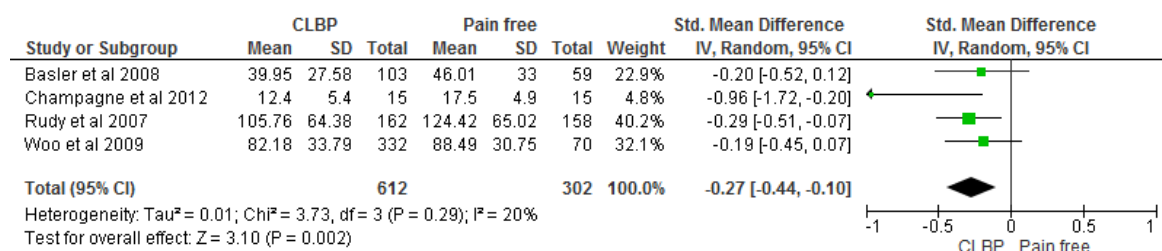


Figure 2.5 Meta-analysis investigating differences in physical activity among those with Chronic low back pain and controls with one study remove (95) (total n=914).



2.4 Discussion

The primary finding from this systematic review and meta-analysis is that older adults with CMP have reduced levels of physical activity compared with asymptomatic controls. The pooled data for the seven included studies demonstrated that the older adults with chronic pain had a profound and significantly lower level of physical activity compared with the asymptomatic controls (-1.74 CI = -2.71 to -0.77, $P < 0.00001$). However, caution must be taken when considering this result as two studies (91, 95), although relatively small in the number of participants (total $N = 248$, $N = 62$, respectively), produced a marked skewing of the data, and the heterogeneity of the included studies was very high and significant ($I^2 = 99\%$). The second updated meta-analysis (Figure 2.3) excluded these two studies and is likely to represent a more accurate reflection of the actual differences in physical activity between the two groups. This analysis of 1,159 older adults with chronic pain established that the levels of physical activity were significantly lower but that the overall SMD was small (-0.20, CI = -0.34 to -0.06, $P = 0.004$). SMD scores of 0.2–0.49 are considered low (66), while scores of 0.5–0.79 and those of 0.8 and above are considered medium and large, respectively. Another important factor indicating that the second meta-analysis is likely to be more representative is that this excluded two studies that represented the two lowest scores on NOS (four each, respectively, (91, 95)). Studies scoring low on the NOS may also introduce bias in the meta-analysis (88). The subgroup analysis of 612 older adults with CLBP and 302 controls demonstrated that the actual difference in physical activity was small but significant (SMD = -0.27, CI = -0.44 to -0.10, $P = 0.002$, $I^2 = 20\%$, $P = 0.29$). The results for global pooled SMD for the five included studies and the subgroup analysis of older adults with CLBP are consistent with the results from a recent review that reported a small subgroup analysis of older adults with CLBP (36). It appears that despite the overall levels of physical activity in the working age population with chronic pain being similar, there is a significant

difference in older adults with CMP. Reasons for this age-associated difference are likely to be complex and multifaceted, but are probably influenced by the higher presence of chronic conditions seen typically within the general older adult population (27). In addition, it is known that physical activity decreases with age (102), and it may be that for those with chronic pain the impact on physical activity is more profound. Another important consideration is that fear avoidance may be a more pertinent issue in older people, with factors such as FOF already known to be high and prevalent in the general older adult population (46). The presence of FOF and other psychological concerns related to falls such as a perceived lower balance confidence could indeed contribute to self-imposed reductions of physical activity in those with CMP, but as yet no author has investigated the impact of musculoskeletal pain on this. Another important consideration is the impact of CMP on sedentary behaviour, which again may be related to heightened concerns about falling. However, the current systematic review was not able to identify any study that measured sedentary behaviour in a sample with and without CMP.

These findings are both a clinical and research concern for a multitude of reasons since the implications of reduced levels of physical activity are particularly profound in this population. Engaging in lower levels of physical activity in older adults is associated with a number of negative health outcomes, including cognitive impairment (103), mobility difficulty/disability (82), and falls (11). The link between reduced levels of physical activity and falls is a concern as falls in old age are a leading cause of accidental death, and this possible relationship warrants exploration (55) and should consider the psychological concerns related to falls. The measurement of physical activity currently being employed in research in older adults with CMP is determined by self-report questionnaires. Studies in working age patients with CLBP have established that a patient's self-reported activity level and the actual activity level registered with an accelerometer do not have a strong association

(104). This brings the results of physical activity as measured by a questionnaire under debate whether this indeed represents a patient's actual activity level. It is widely established that the objective measurement of physical activity through techniques such as the DWT are the "gold standard" (104). Measuring physical activity is complex, and ensuring that researchers accurately measure this is a prerequisite for successfully and accurately determining the association between activity and health outcomes (104). The use of validated questionnaires is common in epidemiological studies, but it is important that future research utilizes objective measures as by their very nature of being objective this method circumvents reporting errors that may develop through misinterpretation, overestimation, and social desirability (104). In the current chapter, only three studies reported on the psychometric properties of the physical activity questionnaire they used (91-93). However, three studies utilized the PASE questionnaire; this has been demonstrated to have good psychometric properties (105, 106). The PASE questionnaire is easy to use, relatively quick to administer, and is widely used in the study of physical activity of older adults and appears to be the most suitable questionnaire in this population. However, a recent small study (106) established that although the test-retest reliability and the intraclass correlation coefficient are acceptable and moderate, the construct validity of the PASE compared with accelerometry was poor. Two studies included in this review (95, 96) utilized the BPAQ (85) questionnaire, and although this is validated and widely used in the working age population, its psychometric properties for measuring physical activity in older adults are undetermined. In summary, research has identified poor association and agreement between self-report measures and objective based measures in CLBP patients. As a result of this, currently the only self-report tool that can be identified for use is the PASE (84). However, clinicians must recognize that the summary score produced by the scale is arbitrary (meaning the level, type, frequency, and intensity of physical activity are not easily identified from the score), and other measures developed for

elderly populations (e.g. Modified Baecke Questionnaire) may be appropriate following appropriate psychometric testing. Given this, it is suggested that researchers who are developing intervention trials should consider the use of objective measures, such as accelerometers or pedometers, to obtain more accurate measures of physical activity. Since no study was identified that considered the measurement of sedentary behaviour, no measure can currently be recommended as a stand out measure.

While the assessment of physical activity in each included study was not optimal, this systematic review is categorically clear that older adults with CMP are less active than those without pain. It is encouraging to note that interventions that seek to increase the levels of physical activity in older people can have far-reaching and profound effects on the increasing older adult population and are an international priority (e.g., WHO (33)). Physical activity programs, such as walking and resistance training, have led to a reduced pain in persons with painful conditions (107). For some older persons, exercises such as swimming and water aerobics may be particularly suitable (107, 108), and physiotherapists are well placed to advise on appropriate adaptive and individualized physical activity programs for people with limitations due to pain. The main focus of these programs should be to increase a person's physical activity level and reduce one's limitation due to pain as pain is not a signal to significantly reduce physical activity levels. This is particularly important in older adults with chronic pain as physical activity is a central strategy in the non-pharmacological management of chronic pain, and prolonged periods of reduced levels of physical activity may have a diverse impact on a range of facets of the older person's health and functioning.

Future research is required to investigate if older adults with CMP are more sedentary than older adults without CMP. Thus, a primary of this thesis was developed to address this gap. It is important that future research considers the factors contributing to sedentary lifestyles in this group so that these can be addressed in clinical practice and subsequent research. In

addition, future research should seek to enquire about older adults with CMP attitudes and beliefs regarding physical activity and sedentary behaviour. This is important to inform future interventional studies that seek to increase overall levels of physical activity and reduce sedentary behaviour in chronic pain. Even when someone is unable to meet the recommended guidance on levels of physical activity, increasing activity levels can have a multitude of beneficial effects on the older person's health and functioning (35). The reasons why older people with CMP engage in lower levels of physical activity are undoubtedly multifaceted and complex, therefore exploration through qualitative methods may be of particular benefit. It is imperative to establish the long-term consequences of reduced levels of physical activity in this population and associations with the fear avoidance model with respect to balance confidence and FOF should be considered. Future research should also investigate current patterns of sedentary behaviour in older people in pain, with a particular focus on sitting behaviour during the waking hours. The beliefs, attitudes, and preferences of the older person toward physical activity warrant investigation, and the development of interventions to promote physical activity should be led by this.

Whilst the current chapter's meta-analysis is the first of its kind, a number of limitations must be contemplated when interpreting the results, which are largely reflected by limitations in the available primary data. First, the cognitive status of the older adults in each study was not considered in most of the studies included. Cognitive impairments are often present in older adults with pain (94), and it is therefore possible that the recall of physical activity in older participants whose cognitive status is unknown may not have been accurate. Only one study (94) excluded older adults with moderate to severe cognitive impairment (Mini Mental State Examination below 18 (109)). Another consideration is that this review includes a large number of older adults with mixed chronic musculoskeletal pain at various bodily sites, and the level of comorbidity varied in each study. Some of the included studies provided clear

information on comorbidity and reported significant differences (97); others found no difference (96), while others did not report it (91). However, it is a clinical reality that most older adults with CMP have numerous comorbidities, and thereby constitutes a particularly vulnerable group (110). In addition, it is known that chronic conditions increase with age, and many older adults present with multiple chronic conditions at any one time (110). Considering the observational design of the studies included in the meta-analysis, it is not possible to identify to what extent other clinical or subclinical conditions may have influenced or reduced the level of physical activity participation. It must be reiterated that the results of this meta-analysis are associations and are not direct cause and effect between chronic pain and physical activity. It may be possible that there was an observed age associated difference in physical activity, while reviews in younger adults did not find this association because of the higher levels of comorbidity typically present in older age.

In addition, there was considerable heterogeneity in the methods of diagnosing and categorizing CMP, although all stipulated the pain had to have been present on most or all days for 3 or more months. It would be helpful if a common consensus were to be established for the diagnosis and classification of CMP and good criteria has been recommended recently (11). Developing uniformity in the way in which CMP is diagnosed and classified would enable better synthesis of results from future trials, and therefore targeted interventions to be developed. A simple diagnosis of CMP may not be sufficient, but a classification such as that offered recently (11) enables analysis of the different subsets of people within the broad spectrum of CMP. Under this classification system, older people diagnosed with CMP may have single site, multiple site, or chronic widespread pain, and pain intensity is also considered. The significance of developing different subsets of CMP is highlighted in the Eggermont et al. (94) study, who completed a subset analysis on older adults with multisite CMP and established that they demonstrated significantly lower levels of physical activity.

However, the combined analysis of all of the subgroups within the CMP classification system revealed no overall significant difference, nor was the subset analysis of those with single or widespread CMP.

2.5 Summary of chapter

In summary, the review of the available literature in this chapter confirms that older adults with chronic pain are significantly less active than those without chronic pain. Although the SMD of the pooled data was small, it is still likely clinically meaningful in the rehabilitation of older adults with chronic pain. Clinicians involved in the rehabilitation of the older person with chronic pain have a vital role in ensuring that this population remains as active as possible not only to manage the chronic pain but also to prevent the multitude of secondary consequences that can arise from being inactive. Future research establishing the relationship among physical activity/ sedentary behaviour levels, pain, falls and psychological concerns related to falls is warranted. Given the findings of the review, priority should be given to investigation of sedentary behaviour in the PhD, especially given the recent findings that higher levels of sedentary behaviour are associated with a range of adverse outcomes in the general population independent of physical activity (35).

CHAPTER 3

IS THERE A RELATIONSHIP BETWEEN PAIN AND PSYCHOLOGICAL CONCERNS RELATED TO FALLING IN COMMUNITY DWELLING OLDER ADULTS? A SYSTEMATIC REVIEW

This chapter is based on the published paper

Stubbs B, West E, Patchay S, Schofield P (2014). Is there a relationship between pain and psychological concerns related to falling in community dwelling older adults? A systematic review. *Disability and Rehabilitation*; 36(23):1931-42.

This chapter relates to primary aim 2 of the thesis.

Overview of the chapter

Psychological concerns related to falling are a common and pervasive problem among older adults yet the relationships with CMP is unclear. The current literature review chapter contains the first systematic review investigating the relationship between pain characteristics and psychological concerns related to falls in community dwelling older adults. The chapter carefully critiques the literature published and found considerable limitations to date. Specifically, the literature review identified that no study exists that had the primary aim of investigating the relationship between pain and any of the four common psychological concerns related to falls constructs. The chapter provides the direction for the future primary research in the thesis and provides a link to the need to appraise the literature regarding pain and falls.

3.1 Introduction

Falls constitute a common problem in old age with over 30% of community dwelling older adults experiencing one or more falls each year and the risk steadily increases with age (55). This is a concern since falls are a leading cause of accidental death and disability in older adults (55, 58, 62). Although most older adults who fall do not experience a physical injury, many develop psychological concerns related to falling which can be equally disabling and disruptive upon an individual's ADL, health, and wellbeing (41, 111).

It has been demonstrated that concerns about falling are not limited to people who have experienced a fall; in fact many older adults are afraid of falling, even though they have not experienced a fall themselves (46). A range of psychological concerns related to falling have been studied in recent years, but the three most common constructs considered to date are FOF, falls efficacy and balance confidence (40, 111). Recent attention has also been given to one further construct; concerns about the consequences of falling (COF). Each of these constructs has been defined in the literature, but there is some inconsistency in the measurement and reporting (111). For definitional purposes, FOF refers to a lasting concern about falling that leads to an individual not performing activities they are capable of doing (112). Falls efficacy is based on Bandura's concept of self-efficacy (113) and refers to an individual's assessment of their own self efficacy in avoiding a fall, whilst balance confidence refers to an individual's confidence that they will be able to maintain their balance and not fall over when doing their ADL (114). Together, these constructs are referred together as "psychological concerns relating to falling" but throughout this chapter individual constructs will be discussed when authors make specific reference to one or more of these.

Clearly having a degree of caution and appropriate behaviour modification to prevent falls is functional when this is composite with an individual's actual physiological falls risk and

promotes safety in the short term (40, 41). However, for some older adults, an excessive concern about falling is disproportionate to their actual falls risk, leading to unnecessary restriction in activities which can further compound functional mobility (42). For instance, severe avoidance of activity due to FOF can, in turn, create a series of problems, including sensorimotor deconditioning and reduced balance which increases the risk of actual falls (41, 50). In addition, FOF is in itself an established risk factor for future falls (58). Moreover, concerns about falling over predicts grey matter loss in the left cerebellum, bilateral inferior occipital gyrus, bilateral superior frontal gyrus and left supplementary motor area, even when adjusting for physiological falls risk (115). Thus, it is evident to see that collectively psychological concerns related to falls are clearly important in older age.

Several studies have investigated factors predisposing older adults to develop psychological concerns related to falls in the literature thus far. These include actual falls, increasing age, female gender, dizziness, depression, anxiety and problems with gait and balance (40, 49). Understanding and identifying risk factors provides clinicians and researchers with valuable information, helping them identify high risk groups so that appropriate interventions can be offered. However, one potential risk factor that appears to have received minimal consideration is pain and in particular CMP. This is surprising since other fear related behaviours, such as the avoidance of physical activity in older adults experiencing pain (although not in relation to FOF) have been the focus of research in recent years (116-118). However, there are reasons to suspect that pain may influence psychological concerns related to falls in older adults. For instance pain can impair an individual's balance, gait and mobility (51), is associated with reduced levels of physical activity and with actual falls (11). Although many of these correlates of pain have been associated with psychological concerns related to falling, the direct association with pain itself remains unclear.

In recognition of the fact that pain and psychological concerns related to falls are common among community dwelling older adults, a systematic review was conducted to investigate this relationship. More specifically the aims of this chapter are: a) to describe the various psychological concerns related to falling that have been measured in older adults with pain, b) to investigate whether psychological concerns about falling are more common in older adults with pain than in older adults without pain and c) investigate any associations reported in the literature between pain and psychological concerns related to falling in community dwelling older adults.

3.2 Method

The systematic review was conducted and reported in accordance with PRISMA statement (83).

Eligibility criteria

In order to be eligible for inclusion, studies had to satisfy the following criteria: 1) conducted in a sample of older adults dwelling in the community with a mean age of 60 years and older. 2) Measured at least one of the following psychological constructs FOF, falls efficacy, balance confidence, avoidance of activities due to a FOF, concerns about the COF, with a validated multi-item questionnaire (e.g. falls efficacy scale) or a single item question. 3) Assessed pain in the sample. Since it was anticipated there would be few studies in the area, studies were included if they recorded any type, site and duration of pain.

Studies were excluded if they were conducted in patients with dementia or cognitive impairment or in samples with recent orthopaedic trauma (within the last year) or orthopaedic surgery (e.g. total hip replacement). The design of the study was not limited; if randomised control trials (RCT) or controlled clinical trials (CCT) were found, the baseline data was used to ascertain the variables of interest. Due to the anticipated paucity of research in the area, non-comparative studies (i.e. studies without a control group) were also included but the results were presented with the appropriate consideration. Only primary data papers providing quantitative data were eligible; reviews, case studies, expert opinions pieces and abstracts were excluded. Finally, only articles written in English were considered for the review.

Information sources

The researcher conducted a systematic review of the literature searching major electronic databases from inception until June 1st 2013, including Cochrane Library, CINAHL, EBSCO, PubMed and PsycINFO. In addition, the reference lists of all eligible articles and recent systematic reviews of the literature were scanned for eligibility. Searches of the online ‘in press’ sections of key journals in the field were also conducted.

Systematic search strategy

The medical subject headings used were ‘fear of falling’ OR, ‘falls efficacy’, OR, ‘fall related psychological concern’, OR ‘balance confidence’ OR ‘consequences of falling’ AND ‘pain’, OR ‘chronic pain’, OR ‘musculoskeletal pain’ AND ‘older adult’, OR ‘old age’ OR ‘elderly’.

Study selection

The researcher first conducted searches following a predetermined strategy screening article titles, key words and abstracts to assess the eligibility. This was repeated by a second independent person. Articles that appeared to meet the eligibility criteria were included for consideration in the full text review. The final list for the full text review was decided by consensus. The researcher conducted a full text review and applied the eligibility criteria and this was finalised through a discussion with a second person. A third person was available for mediation. If overlapping studies were encountered, the most recent and/ or the study with the largest sample size were included. If any clarification was required to determine studies eligibility, the primary author was contacted up to three times over a month period. If no response was received and it was unclear from the original manuscript that a manuscript was eligible, the article was excluded.

Data Collection

The researcher extracted data from each study using a predetermined form and was subsequently verified by a second person. The data collected from each article included: study design, setting, sample characteristics (number, age, % female gender), method of pain assessment, method of assessment of fall related psychological concerns (including reporting of psychometric properties if available), prevalence of fall related psychological concerns in the sample with pain and control group if present and any correlations between pain and psychological concerns related to falling.

Methodological risk assessment

The methodological quality of all included articles was appraised with the NOS (88). This was completed by the researcher and subsequently verified by a second person. Studies without a control group were included due to the paucity of data (119) and were treated as cross sectional case controlled studies for the purposes of methodological assessment. The inclusion of observational studies without a control group in systematic reviews is justified when there is a paucity of literature and reporting such studies can provide valuable information but the results must be interpreted with caution (119). Naturally it was anticipated these studies would have a low methodological quality rating. The NOS assesses the quality of non-randomised trials and its validity and reliability has been established (88) and such criterion is particularly essential when critically appraising studies without a control group (119). The NOS focuses on three main methodological features: 1) the selection of the groups, 2) the comparability of the groups and 3) the ascertainment of the outcome of interest. The NOS has predefined scoring criteria, but some of these can be further specified for the topic of study. The NOS was adapted taking account of age, gender and/ or comorbidity as comparability measures. In addition, the NOS were adapted to consider the

measurement of psychological concerns related to falls in the exposure category. The maximum score that any study can achieve on the NOS is 9 points. Studies that score 5 or more are normally considered of satisfactory methodological quality (88).

Summary measures and Data analysis

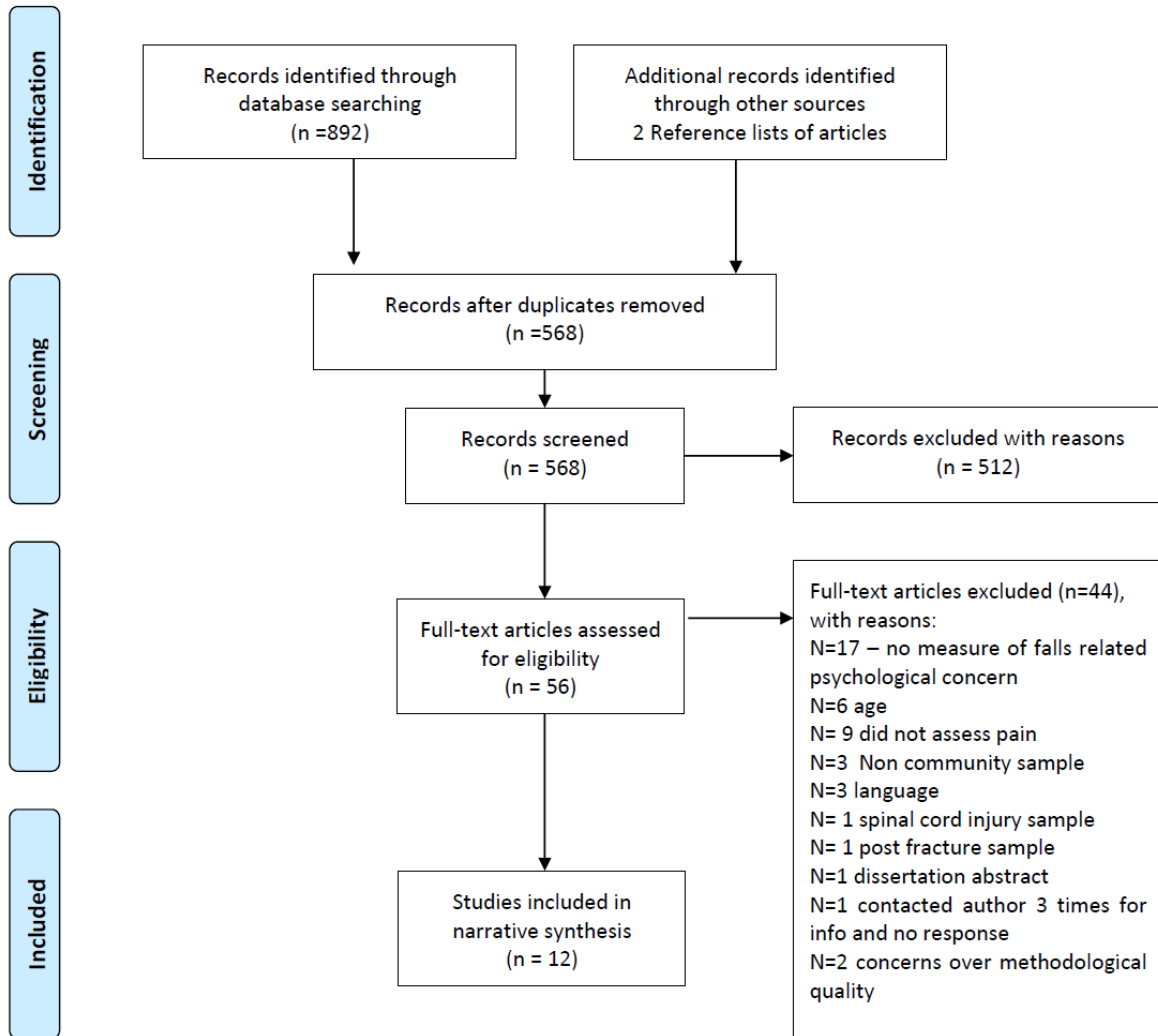
Upon data extraction, it was evident that meta-analysis was not appropriate due to considerable heterogeneity in the study design, and measurement of psychological constructs and pain measurement. Therefore, data were narratively synthesised in a best evidence synthesis.

3.3 Results

Study Selection

The original search yielded 892 articles, which was reduced to 568 after the removal of duplicates. Two additional papers were identified as potentially eligible through additional sources (reference lists of identified articles). The titles, key words and abstracts of each of the articles were screened and when the eligibility criteria were applied, 56 articles were included in the full text review. At the full text review, 44 articles were excluded with reasons (see Figure 3.1). Common factors for exclusion included an absence of measurement of psychological concern related to falls in the sample (n=17), no assessment of pain (n=9) or age (n=6). After the application of the inclusion criteria, 12 articles were included in the narrative review. Full details of the search results are available in Figure 3.1.

Figure 3.1. PRISMA (Moher et al., 2009) flow diagram for search strategy



Study characteristics

Across the 12 studies 3,398 older adults were represented. Details of the studies are summarised in Table 3.1. Six of the included studies employed a cross sectional design (44, 96, 120-123), three were cohort studies (124-126) and the remaining three studies consisted of a cross sectional design but the sample consisted only of older adults with pain (i.e. no control group) (127-129). Thus, the exact number of individuals with pain and controls within the review is not known, since several of the studies did not provide a breakdown of the sample characteristics for these two groups of interest. Only two studies provided clear and separate data for the sample characteristics for those with and without pain (96, 121). In the case of one study, it was not clear whether they had a control group (126) whilst six other studies (44, 120, 123-125, 129) did not provide separate sample characteristics for those with and without pain. None of the included studies had the primary aim of establishing an association between pain and psychological concerns related to falls.

The sample size within each study varied, ranging from the smallest with 30 older adults (15 with CLBP and 15 controls;(96) to the largest which had 684 participants (122). The mean age ranged from 64.2 years (122) to 82.2 years (123) (in the female sample). There was considerable heterogeneity between the comorbidities observed within the samples of each of the included studies and this is summarised in Table 3.1. In the two studies with a clear control group (96, 121) there were no statistically significant differences observed in the age, gender or comorbidity characteristics of the two groups (those with and without pain). In addition, the participants within each study were recruited through a range of different sources, summary information on this and wider demographic information is presented in Table 3.1.

Table 3.1 Details of included studies

Study	Design and setting	Sample characteristics and recruitment sources	Pain ascertainment	NOS score
Billis et al 2011 (120)	Cross sectional cultural validation of FES-I Community (Greece)	N=89 39 (43.8%) female 72.9±6.04 years Convenient sample in 3 local day centres. No separate data on those reporting bodily pain.	SF-36 v2 bodily pain subscale. Pain rated over the past month. Unclear how many reported pain and no pain.	6
Champagne et al 2012 (96)	Case controlled Community (Canada)	N= 30 100% female <i>CLBP</i> N=15 females with 68.9 +6.6 years Recruited from local community. <i>Control group</i> N=15 females without CLBP 69.4 +6.4 years No pain in previous year and never experienced disabling CLBP	6> months CLBP Presented tension, soreness, and/or stiffness in the lower back region with radiating pain limited to the buttocks	6
Cumming et al 2000 (124)	Prospective cohort study Community (Aus)	N=418 completed baseline FES 77.0±7.0 years 57% female All community dwelling but recruited from hospital (84%), outpatient clinics (5%) and local day centres (11%). No separate data on that reporting body pain.	SF 36 score bodily pain taken at baseline and at 12 month follow up. Unclear how many reported pain and no pain.	7
Fessel & Nevitt 1997 (127)	Cross sectional Community (USA)	N=570 all had Rheumatoid arthritis 75.8% female 64.9±8.5 years All sample reported pain at one or more joint Recruited randomly from local rheumatologists. No control group.	Asked about pain at 18 joint sites. Pain severity assessed on scale from 0-100.	3
Fletcher et al 2010 (125)	Cohort study (Pre and Post falls intervention, data in paper looks at risk factors pre and	N=559 81.0±6.4 years 65.8% (n=368) female.	Pain scale as independent variable from the InterRAI CHA.	7

	post falls intervention)	All recruited from a falls prevention initiative.		
	Community (Canada)	No separate data on those reporting pain.		
Hadjistavropoulos et al 2007 (126)	Cohort study Community (Canada)	N=571 (79 did not finish study) 30% response rate 76.6±5.4 years 64% female Retired local citizens	Multidimensional pain inventory pain severity scale (Kerns et al 1985). Three items rating pain from 0 to 6, higher scores indicating higher severity of pain. Authors used total of 3 items to measure pain. Authors add up MPI pain severity scores, unclear if all had some degree of pain or not. However mean MPI pain severity at baseline 5.0±4.7.	7
Hubscher et al 2010 (128)	Cross sectional Community (Germany)	N=82 100% women 73.8±8.1 years 100% osteoporosis Stratified by NRS scores: Mild pain (0-3) n= 19 73.3+7.7years Moderate pain (4-6) n=51 74.5+8.2 years. Severe pain (7-10) n=12 71.7±8.1 years	NRS for back pain	3
Levinger et al 2011 (121)	Case controlled study Community (Aus)	No control group as such, but mild pain group was used as a reference group. N=62 OA group (pre and post-test TKR, baseline data used): N= 35, 67±7 years 45% female. All had OA and 100% had knee pain of varying severity. Control group: N=27, 65±11 years (ns) 53% female (ns) Neither OA nor pain in knees.	WOMAC. Current pain/severity unknown	7
Martin et al 2005 (129)	Cross sectional Community (Canada)	N total=65 60-90 years (mean 64.3±2.41) N=36 55.5% female 70-100 years (mean 77.17±4.88) N= 29 48.2% female	Multidimensional pain inventory (pain severity) score, items rated from 0 to 6, higher scores indicating higher levels of pain.	3

Martin et al 2006 (122)	Cross sectional Community (UK)	All attending physiotherapy clinic and had pain at one or more location, no control group. N=684 100% female 64.2±6 years Convenient sample from primary care practice practices. No separate data for those with and without pain.	SF 36 bodily pain subscale 0 – 100 28.4% sample had mod/ severe bodily pain in past month 19.6% sample had mod/ severe bodily pain interfering with activities. SF 36 short form V2.	7
Moore et al 2011 (44)	Cross sectional study Community (USA)	N=133 77.4% female 74.1±9.5 years Recruited from local community. No separate data for those with and without pain.	Unclear how many reported pain and no pain.	5
Suzuki et al 2002 (123)	Cross sectional Community (Japan)	N=135 92 females (68%) 82.2 years±6.83 43 males 76.14±7.37	SF 36 bodily pain subscale 0-100. Unclear how many reported pain and no pain.	3
		Day centre Service users No separate data for those with and without pain		

Key for table 3.1: FES-I = falls efficacy scale International, SF 36= Short form 36, CLBP = chronic low back pain, MPI = multidimensional pain inventory, NRS= numerical rating scale, WOMAC = Western Ontario and McMaster Universities Arthritis Index, OA= osteoarthritis, NS = non-significant, V2 = version 2.

Table 3.1 also lists the different methods by which pain was assessed. The most common was the Short Form 36 (130) bodily pain subscale which was used in five studies (44, 120, 122-124). Two studies used a numerical rating scale (127, 128) and two studies used the multidimensional pain inventory pain severity scale (131) ((126, 129)).

Methodological Quality of the included studies

The mean NOS score for the included articles was 5.3 ± 1.8 and the summary scores are presented in table 3.1. The methodological quality of the cohort studies was higher 7.0 ± 0.0 compared to the case controlled studies 4.8 ± 1.8 . Four studies scored less than 5 on the NOS raising concerns about the risk of bias and methodological rigour in those studies, which could have influence any observed results reported within their studies. Three of these studies (127-129) had low NOS because they did not have a control group and were treated as a case controlled study and the absence of a control group meant they would naturally score low on the NOS. Each of these studies scored zero (out of a possible 5) that compares the pain and control groups on selection, comparability and exposure.

Measurement of fall related psychological concerns

A diverse range of measures were used and several constructs of falls related psychological concerns were evaluated and are summarised in Table 3.2.

Falls efficacy

Seven studies (44, 120, 121, 124, 126, 128, 129) measured falls efficacy, three (44, 120, 128) of which used the falls efficacy scale international (FES-I (132)), one (121) used the short FES I (133) and three (124, 126, 129) used the falls efficacy scale (FES; (112)).

Balance confidence

Four (44, 96, 126, 129) studies measured balance confidence using the activities balance confidence scale (ABC; (114)).

Fear of Falling and avoidance of activities due to FOF

In total, six studies (44, 122, 123, 125-127) investigated whether there was an association between pain and FOF in their sample. Four studies (122, 123, 126, 127) used a single item question, with two measuring FOF (123, 127) and two investigated whether participants restricted their activities due to FOF (122, 125). In addition, two authors used the survey of activities and FOF in the elderly (SAFFE) or modified version (MSAFFE) to assess FOF (44, 126).

Consequences of Falling

Only one study (44) measured COF using the COF scale (49).

Six (44, 120, 122, 124, 126, 129) of the included articles discussed the psychometric properties of the instrument they used to measure psychological concerns related to falling and all reported that these were acceptable. However, none specifically discussed the psychometric properties in samples of older adults with pain (see table 3.2).

Table 3.2 Results of included studies

Study	Psychological concern related to falling construct measured	Measurement of Psychological concerns of falling	Prevalence of Psychological concerns of falling	Associations between pain and psychological concerns related to falling
Billis et al 2011 (120)	Falls efficacy	FES-I Greek version validation: Criterion related validity correlation with other measures: CONFbal ($r=0.694$, $p<0.01$) Single item FOF question ($r=0.769$, $p<0.01$) Test-retest reliability ICC 0.951 (SEM 1.79 and SDD 20.44%)	Not available for pain and no pain samples.	FES-I scores correlated to SF-36 bodily pain subscale -0.363^* $p<0.01$
Champagne et al 2012 (96)	Balance confidence	ABC scale Psychometric properties not discussed in article.	ABC scores CLBP group $79.5\pm 17.2^*$ $p<0.005$	ABC scores in CLBP group correlated with: ODI scores -0.60^* $p<0.05$
Cumming et al 2000 (124)	Falls efficacy	FES to assess falls related self-efficacy. 10 item questionnaire rate self-efficacy on tasks from 0 (low falls self-efficacy) to 10 (high falls self-efficacy) giving total score from 0 to 100. Authors report FES has good internal consistency ($\alpha=0.91$), test-retest reliability ($r=0.71$) and construct validity (Tinnetti et al 1990).	Control 93.5 ± 4.6 Not available for pain and no pain samples.	FES at baseline and changes in SF 36 bodily pain scores from baseline to 12 months: Bodily Pain scores changed more than any other QOL measure in the study. Low baseline FES (<75) associated with deterioration in pain scores -17.7^* π and -19.4 €^* both $p<0.05$ Moderate baseline FES scores (76-99) associated with deterioration in pain scores -4.6π and -4.7 € (NS) High baseline FES scores (100)

Fessel & Nevitt 1997 (127)	FOF and avoidance of activities due to a FOF	<p>Asked single item question: If they had any fears of falling, those answering yes asked to classify little, somewhat or very FOF.</p> <p>All subjects asked if they limited activities due to concerns or FOF (Yes/ no).</p> <p>Psychometric properties not discussed.</p>	<p>All sample had pain at 1> joint:</p> <p>Level of FOF: None 49.5% A little 24.2% Somewhat 16.7% Very 9.6%</p> <p>Activity avoidance due to FOF: Yes 37.9% No 62.1%</p>	<p>associated with improved pain 2.7π and 3.1 € (NS) FOF group correlates (n=287)</p> <p>Number of mean painful joints* p<0.01 (1.53 vs. 0.99 in no FOF)</p> <p>Number of mean painful lower limb joints* p<0.01 (11.4 vs. 8.6 in no FOF)</p> <p>Pain severity mean* p<0.01 (50.1 vs. 34.5 in no FOF group). Activity avoidance correlates due to FOF: Number of mean painful joints* p<0.01 (11.6 vs. 9.0 in no Activity limitation group) Number of mean painful lower limb joints* P<0.01 (4.5 vs. 3.4 no Activity limitation group) Pain severity mean * p<0.01 (51.6 vs. 36.7 no Activity limitation group). Logistic regression – pain in lower limbs (OR1.20, CI 1.08 to 1.34, p<0.01) significant risk of FOF and in activity limitation due to FOF (OR 1.15, CI 1.03 to 1.28, p<0.05). Pain predictor of activity limitation due to FOF OR 1.78 (CI= 1.41 to 2.24*, p<0.0001)</p>
Fletcher et al 2010 (125)	Avoidance of activities due to a FOF	All respondents were asked if they limited going outdoors because FOF. (Activity restriction due to FOF dichotomised yes/ no).	Not available for those with or without pain.	
Hadjistavropoulos et	FOF and activity restriction	SAFFE includes 3 subscales (FOF, activity avoidance and activity level). Authors report SAFFE has good	Unclear how many had pain, but mean MPI pain severity at baseline 5.0±4.7 and scores	FES predicts future falls in sample* (OR 0.56, CI 0.42 to 0.75, p<0.01) ABC predicts future falls * (OR 1.04, CI

al 2007 (126)	(SAFFE)	psychometric properties.	were: SAFFE FOF 0.35±0.42 Activity avoidance 3.0±2.85 Activity level 9.0±2.38 ABC 83.0±19.5	1.01 to 1.06, p<0.01) SAFFE not able to predict falls.
	Balance confidence	ABC 16 item measure to assess balance confidence each item rated 0-100 (higher scores indicating higher balance confidence). Authors report alpha coefficients of 0.96 (time 1) and 0.97 (time 2).		
	Falls efficacy	FES 10 items to address confidence in carrying out activities without falling (falls self-efficacy). Alpha coefficients of 0.96 (time 1) and 0.97 (time 2).	FES 9.0±1.54	
Hubscher et al 2010 (128)	Falls efficacy	FES-I German validated version. Psychometric properties not reported in article. 16 item scale looking at FOF. Answers from not concerned (1) to very concerned (4). Scores from 16 (no concern of FOF) to 64 (severe concern about falling). Kempen et al 2007 ICC 0.79 Internal reliability mean above 0.90	FES – I scores Mild pain group: 25.9±7.7 Moderate pain group: 28.3±10.6 Severe pain group: 35.7±8.1	Compared pain severity with FES-I scores Mild vs/ moderate p=ns Mild vs. severe p=0.029* Moderate vs. severe p=0.069 All groups p=0.042* Controlling for age, fracture status and history of falls.
Levinger et al 2011 (121)	Falls efficacy	Short FES-I (Kempen et al 2008). Psychometric properties not discussed in article. 7 item Likert scale measure of FOF across 7 activities.	Baseline Short FES-I scores Pain group 11.4±3.0* p<0.05 Control group 7.6 ± 1.2	Not reported.

Martin et al 2005 (129)	Falls efficacy Balance confidence	FES ABC Author reports both have satisfactory psychometric properties.	100% sample had pain. 60-69 year olds: FES 90.97±24.69 ABC 76.96±21.52 70-100 year olds: FES 85.55±17.8 ABC 73.6	Authors conduct a number of analyses but data not available for older adults in the sample.
Martin et al 2006 (122)	Avoidance of activities due to FOF	Single item question ‘in the past 12 months have you limited your activities because you are afraid you will fall?’ Yes/ no (n=70, 10%). Authors report single item question correlates well with SAFFE and the FES.	Not reported for those with and without pain.	62.9% with FOF had moderate to severe body pain vs. 24.4% in non FOF group* p<0.01 55.7% with FOF had pain moderate to severely interfering with activities vs. 15.5% non FOF group* p<0.01 Bivariate correlation: FOF & mod/ severe pain: OR 5.36 (3.1 to 9.4) p<0.01 * FOF & pain mod/ severe interfering with activities OR 6.91 (4.0 to 12.1) p<0.01 * Bodily pain associated with: FES-I -0.32* (CI: -0.46 to 0.16) p<0.01 ABC 0.42* (CI: 0.27 to 0.55) p<0.01
Moore et al 2011 (44)	Balance confidence Falls efficacy FOF and activity restriction (MSAFFE) Concerns regarding the consequences of	ABC FES-I MSAFFE modified survey of activities and FOF in elderly Authors discuss validity and internal consistency (cronbach’s alpha -0.91-0.92, Yardley and Smith). COF scale Reliability confirmed through internal consistency estimates ranging 0.86 to 0.94.	Unclear how many had pain and data not available for those with and without pain.	MSAFFE -0.32* (CI: -0.46 to 0.16) p<0.01 COF -0.24* p<0.01

falling scale.

Suzuki et al 2002 (123)	FOF	Single item question: 'at the present time, are you very fearful, somewhat fearful or not fearful that you may fall?' Afken et al 1994. Psychometric properties not discussed.	Not available for pain and no pain samples	No associations between moderate FOF or nor very FOF and body pain.
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Key table 3.2: FES-I = falls efficacy scale international, FOF = fear of falling, ICC = interclass correlation coefficient, SEM = standard error of the mean, short form 36, ABC= activities balance confidence, CLBP = chronic low back pain, ODI = Oswestry disability Index, FES = falls efficacy scale, QOL = quality of life, NS = non-significant, SAFFE = Survey of Activities and Fear of Falling in the Elderly, OR = odds ratio, MSAFFE = modified Survey of Activities and Fear of Falling in the Elderly, COF = consequences of falling.

Table 3.3: List of studies investigating each psychological concern related to falling construct

Psychological concern relate to falling construct	Studies investigating this construct
<i>Falls efficacy</i>	Billis et al 2011 (120), Cumming et al 2000 (124), Hadjistavropoulos et al 2007 (126), Hubscher et al 2010 (128), Levinger et al 2011 (121), Martin et al 2005 (129), Moore et al 2011 (44)
<i>Balance confidence</i>	Champagne et al 2012 (96), Hadjistavropoulos et al 2007 (126), Martin et al 2005 (129), Moore et al 2011 (44)
<i>FOF/ avoidance of activities due to FOF</i>	Fessel & Nevitt 1997 (127), Fletcher et al 2010 (125), Hadjistavropoulos et al 2007 (126), Martin et al 2006 (122), Moore et al 2011 (44), Suzuki et al 2002 (123)
<i>Concerns about the consequences of falling</i>	Moore et al 2011 (44)

Comparison of psychological concerns related to falling in older adults with and without pain

Only two studies reported the details of fall related psychological concerns in a sample with and without pain, although none assessed pain according to recognised pain assessment guidelines. One study (96) established that those with CLBP had significantly lower balance confidence than the control group (ABC score 79.5 ± 17.2 vs. 93.5 ± 4.6 in control group $p < 0.005$). The other study (121) established those with knee pain had higher concerns about falling (lower falls efficacy) than controls (FES-I 11.4 ± 3.0 vs. 7.6 ± 1.2 in control $p < 0.05$).

Seven other studies reported details of psychological concerns related to falling (44, 120, 122, 125, 126, 128, 129) but failed to report information about a clear control group without pain. This means a comparison between individuals with and without pain is not possible. Three studies (123-125) failed to report the overall score of fall related psychological concerns. These findings are presented in Table 3.2.

Associations between pain and psychological concerns related to falling

In total, ten studies (44, 96, 120, 122-128) reported an association between pain and psychological concerns related to falling in their published papers and all of these except one (123) established at least one significant association. The associations are summarised in Table 3.2. The relationship between pain and each of the psychological concerns related to falls will briefly be considered.

The association between pain and falls efficacy

Two authors (44, 120) established that FES-I scores were correlated with bodily pain whilst another established that low baseline FES scores (<75) were associated with a deterioration in bodily pain scores of -17.7 ($p<0.05$) over 12 months (124). Hadjistavropoulos et al (126) established that the FES was a predictor of future falls in their sample who scored a mean of 5.0 on the MPI. Hubscher et al (128) established a linear relationship between pain and falls efficacy; those with severe pain (7-10 on NRS) had a significantly increased FES-I score (more concerned about falling).

The association between pain and balance confidence

In a sample of CLBP, ABC scores were significantly correlated to the Oswestry disability index scores (ODI) indicating those with higher levels of disability had significantly reduced balance confidence (-0.60 , $p<0.05$). Hadjistavropoulos et al (126) found that ABC scores were predictors of future falls in their sample (their sample scored a mean score of 5.0 on the MPI). Another study found a moderate ($r=0.42$, $p<0.01$) correlation between bodily pain and ABC scores (44).

The association of pain with FOF and avoidance of activities due to FOF

Fessel & Nevitt (127) found a number of relationships between pain and FOF. Those with FOF had a higher mean number of painful joints, higher mean number of painful lower limb joints and higher pain severity mean score compared to those without FOF. The authors found a similar relationship with their sample that was classified as avoiding activities due to FOF. In a logistic regression, the authors established that lower limb pain was associated with significantly increased risk of FOF (OR (odds ratio) 1.20, CI 95%: 1.08 to 1.34, $p < 0.01$) and activity avoidance due to FOF (OR 1.15, CI: 1.03 to 1.28, $p < 0.05$). Fletcher et al (125) found that pain was associated with outdoor activity limitation due to FOF (OR 1.78, CI: 1.41 to 2.24, $p < 0.0001$). Martin et al (122) established that many more of those with FOF had moderate/ severe pain (62.9% vs. 24.4%) and moderate/ severe pain interfering with activities (55.7% vs. 15.5%) compared to the non FOF group (both $p < 0.01$). Moore et al (44) established MSAFFE scores were significantly correlated to bodily pain whilst Hadjistavropoulos et al (126) found that unlike the FES and ABC, the SAFFE was unable to predict future falls in their sample.

The association of pain and Consequences of Falling

Only one study investigated COF and found that this was negatively associated with bodily pain ((44); $r -0.24$, $p < 0.01$).

3.4 Discussion

The current chapter is the first systematic review to investigate the relationship between pain and psychological concerns related to falling in community dwelling older adults. Despite pain and psychological concerns related to falling being two common and pervasive issues for community dwelling older adults, no study was identified whose primary objective was to explore this relationship. There was a considerable amount of heterogeneity in the assessment of pain and psychological concerns related to falls, which presented difficulties when interpreting the results. In addition, considerable heterogeneity was encountered in the comorbidities seen in the respective samples between individual studies. However, there is evidence from two studies of good methodological quality that older adults with pain have a reduced balance confidence (96) and lower falls efficacy (121) compared to those without pain. In addition, ten out of the 12 studies reported an association between pain and one of the psychological concerns related to falling; nine of these were significant. Despite the methodological limitations, the evidence seems to suggest that pain is associated with lower falls efficacy, increased FOF, reduced balance confidence and avoidance of activities due to FOF. Only one study investigated whether there is an association between pain and COF and despite a significant correlation being found, no final conclusions can be made. Given that pain causing interference appears to be particularly problematic, there is a need to investigate how this may affect each of these psychological concerns in future research.

From the current literature, there are indications older adults with pain have a reduced falls efficacy with two prospective studies finding particularly interesting results. Firstly, Cumming et al (124) established a substantial (17.7 points on 0-100 NRS) reduction in bodily pain over 12 months in those with low FES scores (<75). Secondly, Hadjistavropoulos et al (126) established that the FES score was a predictor of future falls in their sample who had a mean score of 5.0 on the MPI. It is not surprising that older adults with pain have reduced

falls efficacy, since pain is known to cause gait disturbances (51) and this is likely to decrease an individual's falls efficacy. The finding from Hubscher et al (128) indicates that the relationship between pain and falls efficacy could be linear; this would be consistent with previous research that has demonstrated that increasing pain intensity is associated with greater physical impairment and increasing falls risk (11, 134). Falls efficacy would be expected to decrease alongside these known changes. The changes in falls efficacy may be an important contributing factor in this previously observed relationship.

The results from the current chapter provide some indication that pain may be associated with reduced balance confidence in community dwelling older adults, although no strong conclusions can be drawn from the available literature to date. One small study (96) demonstrated older adults with CLBP had significantly lower ABC scores compared to the age matched controls with a mean difference of 14% ($p < 0.005$) and demonstrated a large association with disability ($-0.60, p < 0.05$). Pain is closely linked to disability in older adults (135) and affected by other factors such as depression and anxiety (40, 136) and it is not surprising that individuals with CMP in particular may have reduced confidence in completing their ADL without falling over. However, the sample size in Champagne et al (96) was very small ($n=30$) and although interesting the results are clearly not generalisable. Hadjistavropoulos et al (126) established that baseline ABC scores could predict future falls, but the association (OR 1.04, CI: 1.01 to 1.06, $P < 0.01$) was small. In another study, Moore and colleagues (44) utilised four measures to capture each of the psychological concerns related to falling and found that the strongest correlation was between ABC scores and bodily pain. Interestingly, the authors also established that the ABC was able to accurately predict an older adult's propensity to fall. Given this, there is a need for future research to consider the impact of musculoskeletal pain characteristics on balance confidence.

The results from this literature review provide some evidence that pain is associated with FOF and avoidance of activities due to a FOF. Two studies with large sample sizes (122, 127) both found that those classified as having FOF and activity avoidance due to FOF, were likely to report having pain across more body sites and also that the pain they experienced was of greater intensity. Martin et al (122) reported an odds ratio of 5.36 (CI: 3.1 to 9.4) and 6.91 (CI: 4.0 to 12.1) to quantify the relationship with moderate to very severe body pain and pain interfering with activities respectively. The NOS score for this study was high (6) meaning that the methodological quality was acceptable and the risk of bias is likely to be lower than in other studies. Although the Fessel & Nevitt (127) provided interesting results, it should be noted this study gained a low score on the NOS scale due to the lack of a control group to enable comparison and caution should be asserted with conclusions from this study. Interestingly, although Hadjistavropoulos et al (126) established falls efficacy and balance confidence were able to predict future falls, the authors established that the SAFFE was not able to predict future falls. Activity avoidance due to pain is known to occur (117) and it seems plausible that pain may be an important factor that mediates this relationship. The meta-analysis in the previous chapter established that older adults with CMP are less active than those without pain, and activity avoidance due to a FOF could possibly contribute to this observed reduction in physical activity and warrants investigation. In addition, the impact of sedentary behaviour and psychological concerns related to falls is clearly important given that no study has investigated this.

Clinical implications

Pain is frequently encountered by community dwelling older people and the FOF and other psychological concerns related to falls is the most common anxiety reported in older people above others such as fear of being robbed and attacked (49). There is increasing evidence that pain is an important factor associated with lower levels of physical activity (137) and actual falls (11). The presence of any of the psychological concerns related to falls may be an important factor influencing older adults with pain levels of physical activity and falls. Clinicians working with the older adult, who present with pain and in particular CMP, should consider using a detailed falls assessment, including attention to the presence of any psychological concerns related to falling. There is some confusion and overlap between each of the constructs within the spectrum of psychological concerns related to falling. Clinicians should therefore ensure that they are employing the correct outcome measure to capture the phenomenon they wish to measure. In order to avoid confusion, other researchers have suggested that clinicians should simply refer to the terms falls related psychological concerns (40).

Limitations

Whilst the systematic review in this chapter is a first, there are a number of considerations when interpreting the results. Firstly, none of the included studies set out to explore a relationship between pain and psychological concerns related to falls, nor did they set out to establish if this is more prevalent in older adults with pain. Although each of the studies in this review produced useful information about the relationship of interest it was not the focus of any one of the studies; this makes it much more difficult to examine the relationship in a systematic review and precludes the possibility of meta-analytic investigation. Secondly, there was great variation in the methods used to assess pain in the included studies.

Encountering such heterogeneity makes it very difficult to quantify the exact location, nature (e.g. musculoskeletal) and severity of pain and makes comparison across studies difficult. Future work should seek to address this. In addition, a great deal of heterogeneity was evident in the outcome measures used to assess the psychological concerns related to falling, rendering it impossible to conduct a meta-analysis. Further, there was some confusion and mismatching in studies with some reporting they were measuring FOF when they had, in fact, used a falls efficacy instrument (i.e. were measuring falls efficacy and not FOF). This has been reported in other reviews (40, 111) and it is important that future research clearly defines the central construct or constructs and that they employ the appropriate tool to capture that construct or constructs. In addition, there are some methodological concerns about the studies included in this review as indicated by the low NOS scores in some cases. Four studies were found to have a NOS score below 5. In three cases this was attributable due to the absence of a control group and it is important that caution is attached to any conclusions drawn from these studies. Despite these issues, the inclusion of these studies was justified due to the paucity of literature in the area and because they did find significant relationships among the variables of interest, albeit that may be attributed partially due to a lack of methodological rigour. In addition, there was considerable heterogeneity observed between the sample populations within each study of the included studies. Lastly, most (9/12) of these studies were cross sectional making it difficult to explore the exact nature of the association between pain and concerns about falling. Future prospective work would be beneficial to untangle the undoubtedly complex, possibly recursive, relationship between pain and psychological concerns related to falls.

More specifically, there is a need for well-designed research to establish the relationship between older adults with pain and each of the psychological concerns related to falling. Future work should clearly assess the location, type, nature and severity of pain in the sample

and define and accurately measure one or more psychological concerns related to falling. In addition, it is important that future works utilises a homogenous comparison group so that stronger conclusions can be drawn from any results. Future work should also explore the relationship between the different psychological concerns related to falls and sedentary behaviour/ physical activity and actual falls. This work should inform future interventional studies to address these issues in older adults with pain and be applicable to clinicians in practice.

3.5 Summary of chapter

In conclusion, this chapter provides new insight that older adults with pain may be more susceptible to experiencing psychological concerns related to falls, in particular FOF, activity avoidance due to FOF and reduced falls self-efficacy. Pain is a common and pervasive problem in older adults and the association with these factors is likely to impair such individuals functioning and wellbeing further and may be an important moderator in the lower levels of physical activity/ sedentary behaviour and increased risk of falls seen in this group. Future research is required to establish which of the falls related psychological constructs are particularly problematical in older adults with CMP and how this relates to musculoskeletal pain characteristics so that future interventional work can be developed and inform clinical practice. There is a need to understand how pain is associated with falls in order to provide a comprehensive and complete overview and before primary research begins.

CHAPTER 4:

PAIN AND THE RISK OF FALLS IN COMMUNITY DWELLING OLDER ADULTS: A SYSTEMATIC REIVEW AND META-ANALYSIS

This chapter is based on two published papers

Stubbs B, Binnekade T, Eggermont L, Sepehry AA, Patchay S, Schofield P. (2014) Pain and the risk for falls in community-dwelling older adults: systematic review and meta-analysis. Archives of Physical Medicine and Rehabilitation. Jan;95(1):175-187.

Stubbs B, Schofield P, Binnekade T, Patchay S, Sepehry A, Eggermont L.(2014) Pain is associated with recurrent falls in community-dwelling older adults: evidence from a systematic review and meta-analysis. Pain Medicine. Jul;15(7):1115-28.

This chapter relates to primary aim 3 of the thesis.

Overview of the chapter

The current chapter includes the first systematic review and meta-analyses investigating the relationship between pain and falls (including recurrent falls). Numerous subgroup analyses were conducted attempting to disentangle the pain and falls relationship. Of particular importance, the systematic review and appraisal of the literature identified numerous limitations and gaps within the literature to date, which provided the foundation for the development of the primary data collection for the thesis.

4.1 Introduction

Falls among community dwelling older adults are a serious global public health concern (52). The consequences of an older adult experiencing a fall can be profound and may result in functional decline, admission to long term care facilities and increased mortality (58, 62, 138). Research has demonstrated that about 5% of falls lead to a fracture, another 5% lead to other serious injuries (139), but many who fall experience psychological concerns, such as FOF, that increases their risk of future falls (60). In addition, one in four people who fall and half of those acquiring an injury as a consequence will seek treatment from an emergency department or general practitioner (139, 140). Falling is common in community dwelling older adults and each year about 30% and 15% will experience any fall or recurrent falls respectively (139, 141, 142). Naturally, the likelihood of experiencing adverse consequences from a fall is increased in those who fall more often and outcomes are considerably worse in recurrent fallers (140). For instance, compared to those who do not fall or experience single falls, recurrent falls are associated with a more pronounced loss of confidence, greater physician contact, social isolation, greater functional decline, increased likelihood of nursing home admission and mortality(61, 143).

Unsurprisingly, the prevention of falls in older adults is a public health priority in many countries across the world (61). A key component in preventing falls is the identification of important factors that may increase the risk of falls (58, 62). However, the ‘gold standard’ multifactorial interventions to reduce falls have had relatively limited success (144), which may in part be because some important risk factors remain elusive (11). One important and potentially significant risk factor that appears to be continually overlooked is pain (11, 51, 145, 146). For example, the American and British Geriatric Societies (61) provide detailed guidance on the assessment of individuals at risk of falls but there is no specific mention of the assessment of pain or its importance as a falls risk factor. This is surprising for a number

of reasons. Firstly, pain is associated with mobility deficits, impaired gait and balance deficits, all of which are well established internal risk factors for falls (11, 51, 145, 146). Secondly, pain is very common in older people, with up to 76% of older people in the community experiencing it (13).

It is likely that pain has not been identified as a risk factor for falls due to the relative dearth of research specifically investigating the association of pain and falls in older people. Whilst there has been comparatively few authors primarily investigating this, in 1999 a group of authors (147) demonstrated that the presence of severe chronic knee pain was associated with a 50% increased risk of multiple falls. More recently, a large population cohort study (11) also established that CMP was associated with a significantly increased risk of falls. Moreover, in the research to date few have considered the impact of pain and recurrent falls. However, the investigation of a possible relationship between pain and recurrent falls is essential as the prevention of recurrent falls is an international public health priority and those that fall regularly are recognised as a distinct ‘at risk’ group (61, 140). To this end, both the American and British Geriatrics Society (61) and National Institute of Health and Clinical Excellence (NICE) (57) stipulate the need to provide comprehensive assessment for those at risk of recurrent falls; however neither currently recognises that pain may be a risk factor for recurrent falls. This is despite the fact that a number of studies (11, 51, 145) have demonstrated that older adults with pain are at a particularly pronounced risk of recurrent falls over single falls. Studies that explore the association between pain and the risk of falling offer valuable information for clinicians working with older people.

In order to address the current gaps in the literature, the aim of this chapter was to investigate the relationship between pain and falls (including recurrent falls). Previous research (11, 134, 145) has suggested that certain sites and duration (e.g. chronic) of pain may heighten the risk for falls. Therefore, the chapter will seek to disentangle these important relationships. The

primary aim of this systematic review and meta-analysis was to establish if older adults experiencing pain are more likely to have any, single and/ or recurrent falls compared to those without pain.

4.2 Method

The systematic review was conducted and reported in line with the PRISMA statement (83).

Eligibility criteria

Studies were eligible for the review upon meeting the following criteria. 1) The study was conducted in community dwelling older adults with a mean age of 60 years and older. 2) The authors recorded a fall (including any, single or recurrent falls, defined as two or more falls over a monitoring period of at least 12 months (148, 149)) as an outcome,. Falls could be ascertained through either prospective or retrospective measurement. 3) The study assessed pain (through a validated outcome measure, questionnaire or clinical assessment) and there was a sample with and without pain. If the study included participants whose pain was identified as being caused by a previous fall, the study was excluded in order to decrease the likelihood of encountering reverse causality. Studies were also excluded if they were conducted in people with dementia, due to the substantially increased risk of falls in this population and difficulty obtaining accurate records of falls in this population (150). Studies were excluded when falls were reported in people with other neurological conditions such as stroke or Parkinson's disease in order to reduce the influence of major co-morbidity on falls risk. In addition studies were excluded using populations with orthopaedic surgery or trauma in the past 6 months in order to reduce heterogeneity in the results.

Information sources

The researcher and a second person independently conducted searches on major electronic databases from inception until May 2013 including Cochrane Library, CINAHL, EBSCO, EMBASE, PubMed and PsycINFO.

Search strategy

The search terms used were ‘older adults’ or ‘aged’ or ‘elderly’ or ‘old age’ AND ‘pain*’, or ‘chronic pain’, or ‘persistent pain’ or ‘musculoskeletal pain’ AND ‘fall’ and ‘recurrent fall’. When necessary, corresponding authors of articles were contacted to establish if a study was eligible. In addition, all corresponding authors that met the eligibility criteria were contacted to request the raw data for participants from their study who experienced recurrent falls in the samples with and without pain in a 2 X 2 table or incorporating single fallers also in a 2 X 3 design. This was so that the analysis between pain and single and recurrent falls could be investigated in greater detail. The mean age and % of females was also recorded for both groups (pain and no pain) in addition to information on other important falls risk factors.

Study Selection

The researcher screened the titles and abstracts before compiling a list of possible studies that were considered in a full text review. A second person independently checked the list of included studies and a third was available throughout. A final list of included studies was then agreed.

Data collection

The researcher extracted all data which was all subsequently validated by a second person. The data extracted from each study included year of publication, study design, sample size, participant information (age, percentage (%) females), method of pain assessment, falls ascertainment and the number of participants experiencing any falls, single and recurrent falls in participants with and without pain. If a paper reported an association statistic quantifying the relationship between pain and falls this data were extracted together with the 95% CI and *p*-value. Wherever possible, the unadjusted odds ratio (OR, together with 95% CI and *p*-

value) was calculated from the data that authors provided or from data available within the paper. Wherever possible, falls data collected over 12 months was used as this time frame is commonly used in clinical practice and in research algorithms to identify those most at risk of falls (56, 150, 151). Furthermore, this also improved homogeneity in the reporting of results.

Methodological assessment of included studies

The researcher conducted the methodological assessment of all included articles using the NOS (88). A second person independently validated all NOS scores for each of the included articles. The NOS provides an assessment of the quality of non-randomised controlled trials. Each article received a methodological quality score out of 9 and all articles were judged across three key areas: selection, comparability and outcomes. The NOS validity and reliability has been established (88) and scores of 5 out of 9 were considered reasonable quality. The NOS can be adapted and the scores were adapted to give one star to account for age and another for gender or comorbidity. In addition, the requirements for a star were updated when considering the ascertainment of falls in the exposure category and only allocated a star when a valid measure was used to collect falls data (either retrospective or prospective ascertainment).

Summary measures and data synthesis

Wherever possible the raw data from each study were pooled to establish the relationship between pain and any falls, single and recurrent falls in a 2 X 3 table and an unadjusted OR and 95% CI and *p*-value calculated. In accordance with previous research (142) recurrent falls were compared with none and single fallers as the comparison group. In order to establish the 12-month proportion of recurrent falls in older adults with and without pain, a point estimate was calculated. Wherever possible sub group analyses were conducted. To assess the impact of the duration of the pain, subgroup analysis investigating the association

between chronic pain (pain lasting three or more months) and non-chronic pain (pain lasting less than three months) were conducted. Sub group analyses were also conducted investigating the location of pain. Finally, subgroup analyses were conducted to assess the influence of the method of falls ascertainment upon any observed outcomes (prospective versus retrospective falls data collection).

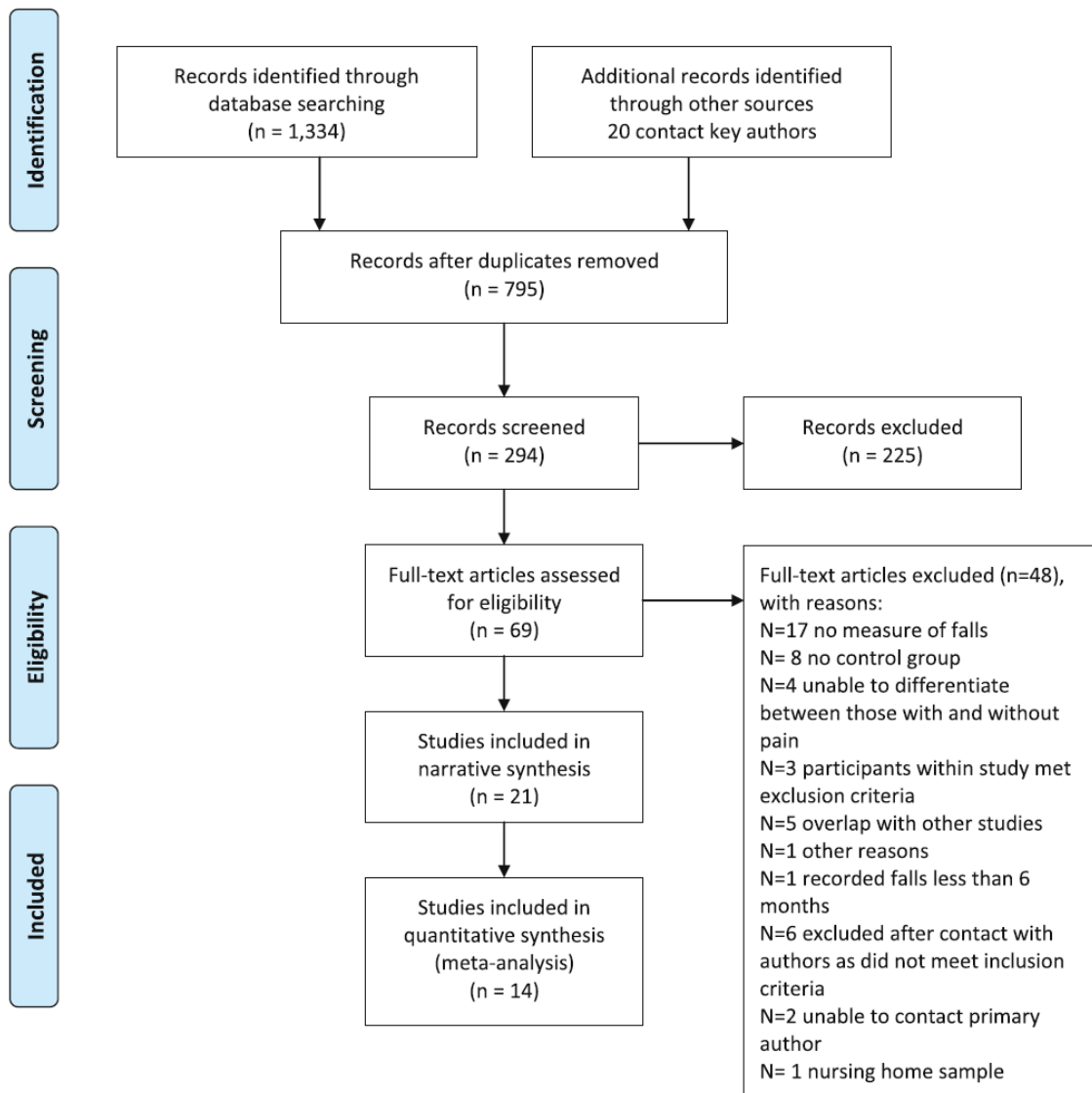
Due to the heterogeneity of the data acquired, the DerSimonian and Laird random-effects model was utilised (152). In order to measure heterogeneity the I^2 statistic was used and scores of 25%, 50% and 75% were considered low, moderate and high heterogeneity respectively (90). An exploratory meta-regression analysis was conducted where possible to investigate the influence of the mean age and % of females on the observed pooled analyses. All analyses were conducted using the Comprehensive Meta-Analysis software (Vers. 2.0). In order to assess publication bias a visual inspection of a funnel plot of all of the included studies in the meta-analysis was undertaken (66).

4.3 Results

Study Selection

The original electronic search produced 1,334 hits and 10 additional articles were found from other sources. After the removal of duplicates, 795 abstracts were examined and 69 articles were considered in the full text review. At this stage, 13 authors were contacted to confirm an articles eligibility requesting additional information and 4 of these were subsequently included in the review (98, 121, 134, 153). In total, 48 articles were excluded with reasons and 21 studies investigating the relationship between pain and any falls were included in the narrative review (11, 51, 98, 121, 134, 153-165) and 14 (11, 51, 98, 121, 134, 153-160) (n=17,926) were eligible for the meta-analysis investigating pain and any falls. All of the 21 authors were contacted to provide separate data for on single and recurrent falls. Altogether, 11 studies investigated pain and recurrent falls (51, 98, 134, 142, 146, 147, 154, 162-164, 166) and were included within the narrative synthesis and 7 (total n=9581: 3950 with pain and 5631 without pain) (51, 98, 134, 142, 146, 154, 166) of these were eligible for inclusion in the meta-analysis. For full details of the search results see figure 4.1.

Figure 4.1 PRISMA flow diagram of search results



Study and participant characteristics

The summary of the 21 included studies is presented in Table 4.1. Seven studies had a case-control design and 14 were cohort studies (see table 4.1). The sample sizes in each study varied considerably, Arden et al (147) was the largest and included 6,441 older adults with 1,427 of those reporting prevalent knee pain, whilst Levinger et al (121) was the smallest and included 62 older adults with 35 experiencing knee pain. The method of ascertaining pain and the location and duration varied considerably in each study and is summarised in Table 4.1. Data on the mean age and gender for two comparative groups (either (a) the pain/ no pain group or (b) fallers/ non fallers), were only available for 13 of the included studies and is presented in Table 4.1. There was considerable inconsistency and heterogeneity in the reporting of comorbidities in each study, with few studies providing clear information on this, but wherever available these are presented in Table 4.1. The method of assessing pain varied and the duration, type and location of pain also varied considerably (see Table 4.1 for more details).

Definition and ascertainment of falls

Nine studies did not provide a definition for a fall (51, 121, 147, 155-158, 161, 163). Seven studies provided a definition for a fall referenced by the literature whilst a further 5 studies offered a definition, but this was not referenced by the literature see Table 4.1 for full details.

Methodological Quality Assessment of included studies

The NOS scores were of acceptable quality for the case controlled (mean 6.28 ± 0.48) and cohort studies (mean 6.6 ± 0.84). Therefore, no studies warranted exclusion over concerns about methodological quality. The NOS summary scores are presented in Table 4.1.

Table 4.1 Summary of included studies

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of NOS score Falls (\geq falls)	
Arden et al 1999 (147)	Cohort study Community (USA)	N = 5552 71.4 \pm 5.1 years 100% female 60.6% confirmed they had self-report physician diagnosed OA. 11.6% had definite radiographic hip OA. Cases matched for both groups. Excluded for RA, Paget's disease, previous hip fracture/ surgery.	Self-report chronic hip pain over 12 months. Chronic hip pain N = 1914 (34.5%) sample	(R) 12 months Recurrent falls	Number of falls in first 12 month follows up. Asked about falls every 4 months.	Not given	Not given	5
Arden et al 2006 (161)	Cross-sectional Community (UK)	Total N = 6641 N = 4026 no knee pain: 78.7 years (76.7 - 81.5) 50.8% female = 1427 prevalent knee pain 78.6 years (76.7 - 81.3 ns) 56.3% females ($p < 0.01$). Patient with knee pain more likely to use walking aid ($p < 0.001$).	Asked if had pain around the knee had most / all days in last month.	(R) 6 months	Questionnaire for falls history	Not given	Not given	7

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1≥ falls)	NOS score
Bekibele & Gureje 2010 (158)	Cross-sectional Community (NGA)	N = 2,096 75.0 ± 9.2 years 47.5% female N = 1700 with chronic pain Fallers 75.2 years vs. non fallers 75.1 years (ns) 78.1% fallers had arthritis vs. 67.7% without arthritis who fell (OR 1.7, CI: 1.0 to 2.7)	Questionnaire on persistent pain in last 12 months	(R) 12 months	Questionnaire for falls history	Not given	(R) Chronic Body pain 87.0% vs. no pain 77.3% (R) Chronic back pain 56.9% vs. no pain 50.1%	6
Blyth et al 2007 (162)	Cross-sectional Community (AU)	N = 3181 65.1% female N = 2227 pain in last 4 weeks (with or without interfering with activity) N = 710 slight pain causing interference N = 711 moderate-severe pain causing interference N = 784 no pain Fallers more likely to use walking aid ($p < 0.0001$), have history of stroke ($p < 0.0001$), arthritis ($p < 0.0001$) use psychotropic medication ($p < 0.0001$)	SF 36 – bodily pain and pain interfering with activities. Last 4 weeks.	(R) 12 months Recurrent falls classed as ≥2 falls over 12/12	Questionnaire for falls history	No reference ‘During the past 12 months, have you had any falls where you have landed on the ground or floor’	(R) Pain over last 4 weeks: No interference 25.6% Slight interference 23.1% Moderate/severe pain 23.2% vs. no pain 28.1%	7

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1≥ falls)	NOS score
Cecchi et al 2009 (159)	Cohort Community (IT)	N = 1006 75.2 ± 7.1 years 56.1% female N = 120 with hip pain: Pain 76.2% females No pain 53.4% females (<i>p</i> <0.01) Pain 75.2 ± 7.2 years No pain 75.2 ± 7.1 years (ns) N = 225 with knee pain: Pain 74.3% females No pain 50.9% females (<i>p</i> <0.01) Pain = 75.4 ± 6.9 No pain = 75.2 ± 7.2 (ns) Covariates: hypertension, peripheral artery diseases, stroke, cardiovascular disease and depression. Foot pain was present in 16-30% of participants.	Questionnaire literature ‘over the past four weeks, did you ever experience hip/ knee pain?’ Also completed WOMAC	(R) 12 months	Questionnaire of if fallen 1≥ times in past 12 months	Yes	(R) Hip pain 32.5% vs. no hip pain 21.1% <i>p</i> = 0.027 (R) Knee pain 30.7% vs. no knee pain 20.1% <i>p</i> = 0.01	6

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (≥ 1 falls)	NOS score
Chaiwaniichsiri et al 2009 (155)	Cross-sectional Community (TH)	N = 213 68.6 \pm 5.4 years 49.2% female N = 30 with foot pain Male: Fallers 70.2 \pm 6.4 years Non fall 68.4 \pm 5.0 years Significant $p < 0.001$ Female: Fallers 69.5 \pm 4.2 years Non fall 68.2 \pm 6.0 years (ns) Fallers more likely to be female ($p < 0.05$), have knee OA ($p < 0.05$)	Foot pain confirmed by physician. Duration/severity unknown	(R) 6 months	Interview history of falls	Not given	(R) ≥ 1 Fall over 6 months Males with foot pain 7.1% vs. no pain 5.3% Females with foot pain 38.7% vs. no pain 16.2%	7
Dai et al 2012 (156)	Cross-sectional Community (USA)	N = 511 N = 372 non fall group: 71 \pm 9.3 years 56.9% female N = 139 in fall group: 75 \pm 11 years ($p < 0.01$) 68.3% female 23% had pain Excluded only if physician or tester regarded it unsafe	Current bodily pain confirmed via questionnaire. No details on location & duration	(R) 12 months	Questionnaire history of falls	Not given	Current pain 32.2% vs. no pain 25.7%	6

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1≥ falls)	NOS score
Kwan et al 2013 (154)	Cohort Community (TW, CN & AU)	N = 1456 N = 692 Chinese and Taiwanese: 74.9 ± 6.4 years 59.4% female N = 764 White Australians: 77.6 ± 4.7 years 56% female 28% (277/ 989) ¹ had pain interfering with activity. Comorbidities analysed were cerebro- and cardiovascular conditions, diabetes, osteoarthritis, incontinence, dizziness, Parkinson's disease and depressive symptoms. Separate comorbidity data for each groups were not available.	Questionnaire on current pain interfering with activity. No details on location & duration	(P) 12-24 months Recurrent falls classed as ≥2 falls	Chinese sample: monthly telephone calls for 12-24 months. Australian white sample monthly falls calendars 12-24 months.	Yes	Not given	6

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1≥ falls)	NOS score
Leveille et al 2002 (51)	Cohort Community (USA)	N = 1002 100% female N = 295 no pain N = 189 other pain N = 293 lower extremity pain N = 225 widespread pain Age (years) No pain 80.2 ± 8.1 Other pain 78.8 ± 7.7 Lower extremity pain 77.3 ± 8.4 Widespread pain 76.5 ± 7.3 (<i>p</i> <0.001) OA of knee: No pain 12.9% Other pain 30.7% Lower extremity 49.8% widespread pain 49.3% (<i>p</i> <0.001). OA of hip No pain 1.2%, Other pain 7.4% Lower extremity pain 11.6% Widespread pain 11.6%	NRS for hip and knee pain over past month	(R) 12 months 3 year follow up (R) falls history classed as ≥2 falls	Interview on falls history past 12 months. Home interview every 6 months to establish further falls	Not given	(R) Other pain 35.5% (R) Lower extremity pain 31.9% (R) Widespread pain 40.4% vs. no pain 28.5%	6

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assess	Definition of falls	Prevalence of Falls (1≥ falls)	NOS score
Leveille et al 2009 (11)	Cohort Community (USA)	N = 748 All >70 years 63.2% female N = 267 no pain (35.6%) N = 181 single site pain (24.2%) N = 300 polyarticular pain (40.1%) OA at any site: No pain 11.6% Single site 35.9% Polyarticular 60.5% ($p<0.01$) RA: No pain 2.6% Single site pain 3.9% Polyarticular pain 8.0% $p=0.03$ Polyarticular group also more likely to have depression ($p<0.01$) and peripheral arterial disease ($p<0.01$) and heart disease ($p=0.008$).	13 item joint pain questionnaire to establish chronic pain in hands, wrist, shoulders, back, chest, hips, knees and feet. Chronic pain ≥ 3 months.	(R) 12 months & (P) up to 18 months	Retrospective 12 months falls history questionnaire. Prospective monthly falls calendars for up to 18 months and follow up telephone calls	Yes	(R) Single site pain 38.3% (R) Polyarticular pain 44.2% vs. no pain 28.3%	6

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1≥ falls)	NOS score
Levinger et al 2011 (121)	Case-controlled Community (AU)	N = 62 OA group: N = 35, 67 ± 7 years 45% female. All had OA and knee pain. Control group: N = 27 65 ± 11 years (ns) 53% female (ns) Neither OA nor pain in knees.	WOMAC. Current pain/ severity unknown	(R) 12 months	12 months falls history	Not given	(R) Current knee pain 48% vs. no pain 30%	6
Menz et al 2006 (160)	Cohort Community (AU)	N = 176 80.1 ± 6.4 years 68.1% female 21.6% had ‘disabling’ foot pain. Remainder had no foot pain, but other conditions such as osteoarthritis were present in some. Fallers 81.4 ± 6.4 years vs. non fallers 79.1 ± 6.3 years (p=0.022)	Manchester Foot Pain and Disability Index (MFPDI), which required participants to have current pain, to have pain lasting for at least 1 month	(P) 12 months	Monthly falls calendars for 12 months with follow up telephone calls for non-returners	Yes	(P) Foot pain 60.5% vs. no pain 27.7%	6

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1≥ falls)	NOS score
Mickle et al 2010 (166)	Cohort Community (AU)	N = 312 49.3% female 50% had foot pain 50% no foot pain, comorbid problems not mentioned. Fallers 71.6 years (CI = 70.4–72.9) Non fallers 71.2 years (CI = 70.3–72.2) (ns) 54% Fallers female 46.4% non-fallers female (ns)	Manchester Foot Pain and Disability Index. Duration & severity unknown	(P) 12 months Recurrent falls classed as ≥2 falls over 12/12	Monthly falls calendars for 12 months	Yes	(P) Foot pain 57.9% vs. no pain 42.1%	7
Morris et al 2004 (163)	Cross-sectional (baseline data) Community (AU)	N = 1000 73.4 (65-94 range) 53.3% female Unclear number of participants who had chronic pain (12> months) Excluded for cognitive impairment or serious illness.	Pain frequency measured 5 point Likert scale (never to everyday) over past 12 months	(R) 12 months Recurrent falls classed as ≥2 falls over 12/12	Face to face interviews falls history over past 12 months	Not given	Not given	7

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1≥ falls)	NOS score
Muraki et al 2011 (145)	Cross-sectional Community (JP)	N = 1675 Male ages in years Non fallers 66.4 ± 11.7 Single fallers 67.6 ± 11.9 Multiple fallers 64.6 ± 11.3 (ns) Female ages in years: Non fallers 64.4 ± 12.1 Single fallers 64.3 ± 12.2 Multiple fallers 69.1 ± 10.4 (<i>p</i> = 0.004) 64.9% of total sample female. 24.4% had chronic knee pain (over past 12 months) 20.1% chronic LBP OA knee higher in females (<i>p</i> <0.05) Female multiple fallers more likely to have OA knee (<i>p</i> = 0.0002), males (ns). No comorbidities measured.	Assessment by orthopaedic doctor. Asked if had pain on most days in past year in hip and lower back.	(R) 12 months	Interview by doctor obtaining 12 months falls history.	Yes	Not given	7
Muraki et al 2013 (146)	Cohort community (JP)	N = 1348 with baseline and follow up data N = 452 males, 64.9 ± 11.7 years N = 896 females, 63.3 ± 11.8 years 69/453 males had knee pain 230/896 females had knee pain 85/452 males had LBP 193/896 had LBP Data on LBP and falls not available	Asked if had pain a) knee and b) LBP for most days in past month.	3 year (R) over follow-up Recurrent falls classed as ≥2 falls in 3 year follow up	Interview at follow up.	Yes	Not given	7

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1> falls)	NOS score
Nahit et al 1998 (157)	Case-controlled study Community (UK)	N = 361 N = 111 with new episode of musculoskeletal hip pain median age = 66, IQR 56–72 years 68% female N = 251 age and gender matched controls no hip pain in previous 12 months.	Attendees at GP for musculoskeletal hip pain. No prior hip pain in past 12 months	(R) 12 months	Questionnaire falls history past 12 months	Not given	(R) Hip pain 30.2% vs. no pain 20.2%	6
Nevitt et al 1989 (164)	Cohort study Community (USA)	N = 325, 83.1% female 60> years, mean ages not available. All had reported at least one fall in past 12 months. N = 32 had hip or knee pain No difference in gender between falls vs. no falls group.	Underwent doctor examination and had hip and/ knee pain on passive movement.	(P) 12 months Recurrent falls classed as ≥ 2 falls over 12/12	Weekly postcards for 12 months & telephone calls for non- returners	Yes.	Not given	6
Stel et al 2003 (142)	Cohort Community (NL)	N = 1365 74.8 \pm 6.2 years non/ single fallers 76.8 \pm 6.8 years recurrent fallers (p<0.01) 51.0% female non/ single fallers 51.6% females non/ single fallers 27.3% non/ single fallers had pain 39.5% recurrent fallers had pain	Asked if had pain in past 4 weeks	3 years (P) falls calendars Recurrent faller classed as person who had ≥ 2 falls over 6/12	falls calendars	Not given	Not given	8

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1≥ falls)	NOS score
Sturnieks et al 2004 (134)	Cross-sectional Community (AU)	N = 679 participants N = 283 arthritis (41.3%): 80.2 ± 4.3 years 74.6% female N = 401 no arthritis: 80.0 ± 4.6 years (ns) 58.6% female (<i>p</i> <0.05) N = 231 had pain N = 416 no pain N = 32 not available	Asked SF 12 question in last 4 weeks have you had pain interfering with activity. N = 106 a little pain N = 71 moderate N = 51 quite a lot N = 3 unclear if those with pain had arthritis or not.	(R) 12 month Recurrent falls classed as ≥2 falls over 12/12	Falls history	Yes	(R)Pain intensity falls rate: A bit 45.7% Moderate 47.8% Quite a lot 62.7% A lot 100% No pain 39.4%	6
Tromp et al 1998 (165)	Cross-sectional Community (NL)	N = 1469 72.6 ± 5.2 years 52.0% female Unclear how many participants had pain. Presence of chronic diseases assessed and analysed, including COPD, cardiovascular disease, stroke, urinary incontinence, diabetes mellitus, joint disorders, and malignant neoplasms. Assessment of distance vision and hearing.	Nottingham health profile used for pain. Unknown location or duration for pain	(R) 12 months	12 months falls history	Yes	Not given	8

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1> falls)	NOS score
Woo et al 2009 (98)	Cohort Community (HK)	N = 4,000 72.49 ± 5.18 years 50.0% female Average age male groups 72.4 ± 4.9 years. Non-significant difference between any of the pain groups (including no pain). Average age female groups 72.7 ± 4.8 years. Non-significant difference between any of the pain groups (including no pain). Chronic diseases added as covariate.	Participants were asked about the presence of hip, knee and back pain over the past 12 months. Respondents could indicate: 0 Never 1. Rarely 2. Some of the time 3. Most of the time 4. All of the time (3&4 classified as chronic pain).	(P) 4 years (R) 12 months Recurrent falls classed as ≥2 falls over 12/12	(P) Participants were asked to record falls as they happened and they were contacted by telephone every 4 months for results over 4 years. Retrospective: 12 months recall of falls at five year follow up.	Yes	(P) 44% with chronic pain (mixed body sites) fell. 31.9% with no pain fell.	7

Study	Design and setting	Participant information	Pain ascertainment location severity	Falls reference period	Mode of falls assessment	Definition of falls	Prevalence of Falls (1≥ falls)	NOS score
Yagci et al 2007 (153)	Cross-sectional Community (TR)	N = 240 61.52 ± 8.2 years 45.0% female N = 163 with pain Excluded for musculoskeletal injury or psychiatric disorder.	Asked if had musculoskeletal pain in lower body in past 6 months. Average pain intensity over past 6 months scored VAS 0-10	(R) 12 months	Falls history in past 12 months	Yes.	Not given	6

Key: NS = non-significant, (R) = retrospective falls ascertainment, (P) = prospective falls ascertainment, VAS = visual analogue scale, OA = osteoarthritis, RA = rheumatoid arthritis, SF 12 = short form 12, SF 36 = long form 36, COPD = chronic obstructive pulmonary disease, IQR = interquartile range, WOMAC = Western Ontario and McMaster Universities Arthritis Index, GP = general practitioner, MFPDI = Manchester Foot Pain and Disability Index, LBP = low back pain, OR = odds ratio, CI = confidence Interval, NRS = numerical rating scale, AU = Australia, CN = China, HK = Hong Kong, IT = Italy, JP = Japan, NGA = Nigeria, NL = Netherlands, TH = Thailand, TR = Turkey, TW = Taiwan, UK = United Kingdom, USA = United States of America

Percentage of falls reported by older adults with and without pain

It was possible to calculate the mean percentage of fallers (one or more fall) over 12 months for the older adults with and without pain utilising the raw data from 11 studies (51, 98, 121, 153, 154, 156-160, 166) with the data from the 2 X 2 tables. This established that 50.5% of older adults with pain reported one or more fall over 12 months compared to 25.7% of the control group ($p < 0.001$). Furthermore, the mean percentage of recurrent falls was calculated from 6 studies and this established that 12.9% (463/ 3573) older adults with pain reported recurrent falls compared to 7.2% (335/4603) older adults without pain ($p < 0.001$).

Association between pain and falls in the individual studies

Twelve studies reported an adjusted association statistic to quantify the relationship between pain and any fall and each of these reported at least one positive association between pain and falls (details in table 4.2). Seven studies reported an association statistic within their paper establishing an increased risk of falls (results in table 4.2). A wide range of association statistics were used together with the adjustment of multiple confounding factors. It was possible to calculate the unadjusted OR from the raw data for 14 studies (11, 51, 92, 112, 125, 144-151) investigating the relationship between pain and any falls. All of the results investigating pain and any falls are presented in table 4.2.

In addition, it was possible to calculate the unadjusted OR of the relationship between pain and recurrent falls from 7 studies. Details of the unadjusted OR and 95% CI investigating pain and recurrent falls are presented in table 4.3.

Table 4.2 Results of Adjusted Association statistics and Unadjusted Odd ratios between pain and any fall

Study	Pain	Falls Ascertainment	Association Statistic for falls risk	Adjusted for
<i>Hip Pain</i>				
Arden et al 1999 (147)	Chronic Hip pain	12 months (R)	RR 1.5 (CI: 1.3 to 1.8) <i>for 2> falls</i>	Age, knee height, weight, clinic.
Leveille et al 2009 (11)	Chronic Hip pain	18 months (P)	RaR 1.23 (CI: 0.56 to 2.69)	≠
Nevitt et al 1989 (164)	Current hip/ knee pain	12 months (P)	RR 1.9 (CI: 1.3 to 3.7) <i>for 2> falls</i>	Unadjusted
Cecchi et al 2009 (159)	Hip pain over last 4 weeks	12 months (R)	OR 1.33 (0.85 to 2.10) P = 0.2082	Raw Data
Nevitt et al 1989 (164)	Current Hip pain	12 months (R)	OR 1.70 (0.90-3.21) p= 0.0976	Raw Data
Woo et al 2009 (98)	Chronic Hip pain	12 months (R)	OR 1.16 (0.66-2.03) p=0.5879	Raw Data
<i>Knee pain</i>				
Arden et al 2006 (161)	Knee pain over last month	6 months (R)	HR: 1.26 (CI: 1.17 to 1.36)	Unclear
Arden et al 2006 (161)	Severe knee pain over last month	6 months (R)	HR: 1.51 (CI:1.32 to 1.72)	Unclear
Leveille et al 2009 (11)	Chronic Knee pain	18 months (P)	RaR 0.95 (CI 0.60 to 1.49)	≠
Muraki et al 2011 (145)	Chronic Knee pain	12 months (R)	1> fall OR 1.20 (CI: 0.79 to 1.81) 1> fall OR 1.00 (CI: 0.62 to 1.61) 1> fall OR 0.99 (CI: 0.60 to 1.61) 2> fall OR 2.52 (CI: 1.58 to 4.02) 2> fall OR 1.61 (CI: 0.92 to 2.79) 2> fall OR 1.87 (CI: 1.06 to 3.28)	Unadjusted † ‡ Unadjusted † ‡
Cecchi et al 2009 (159)	Knee pain over last 4 weeks	12 months (R)	OR 1.75 (CI=1.26 to 2.45) P = 0.0009*	Raw Data
Levinger et al 2011 (121)	Current knee pain	12 months (R)	OR 2.24 (0.77 to 6.46) P = 0.134	Raw data
Woo et al 2009 (98)	Chronic knee pain	12 months (R)	OR 1.00 (0.72-1.39) p=0.981	Raw data

<i>Back/ Neck Pain</i>				
Bekibele & Gureje 2010 (158)	Chronic Back/ neck pain	12 months (R)	OR 1.3 (CI: 1.0 to 1.7)	Age & gender
Leveille et al 2009 (11)	Chronic back pain	18 months (P)	RaR 1.37 (CI: 0.75 to 2.50)	≠
Morris et al 2004 (163)	Chronic Back pain	12 months (R)	1 > fall OR 1.54 (CI: 1.10 to 2.16) P=0.01* 2> Fall OR 3.90 (CI: 2.49 to 6.16) P<0.001*	Unadjusted Unadjusted
Muraki et al 2011 (145)	Chronic LBP	12 months (R)	1> fall OR 1.28 (CI: 0.82 to 1.96) 1> OR fall 1.34 (CI: 0.84 to 2.08) 1> fall OR 1.33 (CI: 0.84 to 2.08)	Unadjusted † ‡
			2> fall OR 2.14 (CI: 1.30 to 3.46) 2> fall OR 1.72 (CI: 1.01 to 2.88) 2> fall OR 1.58 (CI: 0.91 to 2.70)	Unadjusted † ‡
Woo et al 2009 (98)	Chronic back pain	12 months (R)	OR 1.14 (0.85-1.51) p=0.3625	Raw data
	Chronic back pain causing interference with activities		OR 0.87 (0.48-1.56) p=0.6474	Raw data
<i>Foot Pain</i>				
Leveille et al 2009 (11)	Chronic foot pain	18 months (P)	RaR 1.07 (CI: 0.62 to 1.84)	≠
Chaiwanichsiri et al 2009 (155)	Current foot pain	6 months (R)	OR 3.60 (1.59 to 8.16) P = 0.0021*	Raw data
Chaiwanichsiri et al 2009 (155)	Current foot pain	6 months (R)	OR 2.5 (1.03 to 6.12) p=0.043*	Unclear
Menz et al 2006 (160)	Foot pain over last month	12 months (P)	OR 2.84 (1.35-5.95) p=0.0056* data	Raw
Mickle et al 2010 (166)	Current foot pain	12 months (P)	OR 1.87 (1.16-3.02) p=0.0098* data	Raw
<i>Unspecified/ Any Body Pain</i>				
Bekibele & Gureje 2010 (158)	Chronic body pain	12 month (R)	OR 1.96 (1.51 to 2.55) P<0.0001*	Raw data
Bekibele & Gureje 2010 (158)	Chronic body pain	12 months (R)	OR 1.9 (CI: 1.1 to 3.4)	Age and gender

Dai et al 2012 (156)	Current body pain	12 months (P)	OR 1.37 (CI: 0.87 to 2.14) p=0.1648	Raw Data
Kwan et al 2013 (154)	Current Body pain	12 months (P)	OR 1.46 (1.078 – 1.985) P=0.014*	Raw data
Kwan et al 2013 (154)	Current body pain	12-18 months prospective	IRR: 1.40 (CI: 1.08 to 1.80)	Age and gender
Morris et al 2004 (163)	Chronic body pain frequency 'sometimes'	12 months (R)	1>Fall OR 1.52 (CI: 0.98 to 2.35) P=0.06 2> fall OR 2.52 (CI: 1.41 to 4.51) P=0.002*	Unadjusted
	Chronic body pain 'frequent'		1> fall OR 1.19 (CI: 0.80 to 1.77) 2> fall OR 2.86 (CI: 1.74 to 4.71) P<0.001*	Unadjusted
Woo et al 2009 (98)	Chronic pain mixed	4 year (P)	OR 1.67 (1.34-2.08) p=0.0001*	Raw data
Yagci et al 2007 (153)	Chronic body pain	12 months (R)	OR 11.79 (2.76- 50.26) P = 0.0008*	Raw data
Tromp et al 1998 (165)	Current body pain	12 months (R)	1>fall OR 1.1 (CI: 1.0 to 1.2) p< 0.05* 2> OR 1.2 (CI: 1.1 to 1.4) P< 0.05*	Unclear

Single site vs. Widespread Pain

Leveille et al 2002 (51)	Other pain last month	Risk of falls over 3 year follow up	OR 1.36 (CI: 1.02 to 1.82)	£
	Lower extremity pain last month	Risk recurrent falls over 6 months	OR 1.27 (CI: 0.97 to 1.66)	£
	Widespread pain last month		OR 1.66 (CI: 1.25 to 2.21)	£
	Other pain last month		OR 1.54 (CI: 1.01 to 2.35)	£
	Lower extremity pain last month		OR 1.38 (CI: 0.93 to 2.03)	£
	Widespread pain last month		OR 1.66 (CI: 1.10 to 2.50)	
Leveille et al 2002 (51)	Pain over last month:	12 months (R)	OR 1.39 (1.00 -1.92) p=0.0450*	Raw data
	Pooled pain data of all types of pain		OR 1.39 (0.92-2.099)	Raw data
	Other pain		OR 1.17 (0.807-1.714)	Raw data
	Lower extremity pain		OR 1.718 (1.16-2.53) p=0.007*	Raw data
	Widespread			

	pain			
Leveille et al 2009 (11)	Chronic pain overall: Single site Polyarticular	12 months (R)	OR 1.83 (1.33-2.53) p=0.000* OR 1.57 (1.05 - 2.35) P = 0.0261* OR 2.01 (1.41 - 2.85) P = 0.0001*	Raw data Raw data Raw data
Leveille et al 2009 (11)	Single site pain Polyarticular pain	18 months (P)	RaR 1.19 (CI: 0.90 to 1.56) RaR 1.70 (CI: 1.34 to 2.20)	Age, sex, education
Leveille et al 2009 (11)	Pooled chronic pain	12 months (P)	OR 1.86 (CI: 1.37 to 2.52 p=0.0001*	Raw data
<i>Pain severity / interference with activity</i>				
Blyth et al 2007 (162)	Pain last 4 weeks & interference with activity	12 months (R)	<i>No interference</i> 1>fall PR 1.15 (CI: 0.97 to 1.37) 2>PR 1.31 (CI: 0.92 to 1.86) <i>Slight interference</i> 1>fall PR 1.37 (CI: 1.16 to 1.62) 0.0002* 2>fall PR 1.66 (CI: 1.19 to 2.33) 0.0032* <i>Moderate interference</i> 1>fall PR 1.72 (CI : 1.47 to 2.00) <0.0001* 2> PR 2.29 (CI: 1.67 to 3.13) <0.0001*	Age & Gender
Sturnieks et al 2004 (134)	Severity of pain: Pooled pain data A bit of pain Moderate pain Quite a lot of pain A lot of pain	12 months (R)	OR 1.57 (CI: 1.14 to 2.18) p=0.0059 OR 1.27 (CI=0.82 to 1.95) P = 0.2734 OR 1.41 (CI=0.85 to 2.34) P = 0.1810 OR 2.58 (CI=1.41 to 4.71) P = 0.0019* OR 10.74 (CI=0.55 to 209.38) P = 0.1171	Raw data Raw data Raw data Raw data
Leveille et al 2009 (11)	Chronic Pain severity Chronic pain interference with activities	18 months (P)	Moderate RaR 1.19 (0.92-1.53) High RaR 1.54 1.18- 2.01) Moderate Interference: RaR 1.44 (1.11-1.85) High Interference: RaR 1.67 (1.31-2.14)	Age, gender & education

Key table 4.2: RR – Relative risk, HR – Hazard ratio, (P) – Prospective ascertainment of falls, (R) – Retrospective ascertainment of falls, RaR – Rate Ratio, OR – Odds Ratio, IRR – Incidence risk ratio, PR – Prevalence ratio, LBP – low back pain, Raw data – unadjusted OR calculated from raw data.

Key for Adjustment of confounding factors:

≠ Leveille et al 2009(11) binomial regression - age, sex, race, education, heart disease, diabetes, Parkinson disease, history of stroke, vision score, body mass index, neuropathy, cognitive function, physical activity, balance test score, repeated chair stand time, gait speed, use of psychotherapeutic medications, daily use of analgesic medications, hand and knee osteoarthritis clinical criteria excluding pain

† = Muraki et al 2011 (145) multinomial logistic regression analysis with age, body mass index, cognitive impairment, radiographic knee OA, knee pain, radiographic LS, and lower back pain as independent variables

‡ = Muraki et al 2011(145) multinomial logistic regression analysis with grip strength, 6-meter walking time, and chair stand time in addition to † independent variables

£ - Leveille et al 2002 (51) - Adjusted from discrete time survival analysis (using logistic regression), updating pain level to most recent follow-up interview before event. Covariates included age, race, education, body-mass index, confirmed diseases (hip fracture, angina pectoris, diabetes mellitus, peripheral arterial disease, stroke, Parkinson's disease), walking disability, fell in 12 months before baseline, Mini-Mental State Examination score, daily use of psychoactive medications, daily use of analgesic medications, gait speed, balance test score, proxy respondent, and follow-up round.

Table 4.3 Results for Association between pain and recurrent falls

Study	Pain details	Falls Ascertainment	Association Statistic recurrent falls	Adjusted for
Arden et al 1999 (147)	Chronic Hip pain	12 months (R)	RR 1.5 (CI: 1.3 to 1.8)	Age, knee height, weight, clinic. Age and gender
Blyth et al 2007 (162)	Pain over last 4 wk: No interference with activities	12 months (R)	PR 1.31 (CI: 0.92-1.86)	
	Slight interference with activities		PR 1.66 (CI: 1.19-2.33)	
	Moderate to severe interference with activities		PR 2.29 (CI: 1.67-3.13)	
Kwan et al 2013 (154)	Current pain	12 months (P)	OR 1.75 (CI:1.14 -2.68) Recurrent vs. None/ single fallers	Calculated from raw data
			OR 1.96 (1.27 - 3.04) Recurrent vs. non fallers only	
Leveille et al 2002 (51)	Pain over last 4 wk Other pain Mod/ severe pain in lower extremities	3 year (R)	OR 1.54 (CI: 1.01-2.35) OR 1.38 (CI: 0.93-2.03) OR 1.66 (CI:1.10-2.50)	£
	Widespread pain	12 months (R)	OR 1.66 (CI: 1.03 – 2.68) Recurrent vs. none/ single fallers	Calculated from raw data
	Pooled pain data		OR 1.967 (CI: 1.20 – 3.21) recurrent vs. non fallers only	
Mickle et al 2010 (166)	Foot pain	12 months (P)	OR 2.50 (CI: 1.18 – 5.29) Recurrent vs. none/ single fallers	Calculated from raw data
			OR 2.67 (1.24 – 6.73) Recurrent vs. non fallers only	

Study	Pain details	Falls Ascertainment	Association Statistic recurrent falls	Adjusted for
Morris et al 2004 (163)	Frequency of pain over 12 months: Sometimes Frequent	12 months (R)	OR 2.52 (CI:1.41-4.51) OR 2.86 (CI:1.74-4.71)	Unadjusted
Muraki et al 2013 (146)	Pain over past month in knee Male Female	3 year (R)	OR 2.05 (CI:0.99-4.00) OR 2.22 (CI:1.44-3.37) OR 1.98 (CI: 1.39-2.8252) Recurrent vs. none/ single fallers OR 2.05 (CI: 1.44 – 2.93) Recurrent vs. non fallers only	Crude Calculated from raw data
Nevitt et al 1989 (164)	Current hip/ knee pain	12 months (P)	RR 1.9 (CI:1.3-3.7)	Unadjusted
Sturnieks et al 2004 (134)	Pooled pain data over past month	12 months (R)	OR 3.02 (CI: 2.04 - 4.48) Recurrent vs. none/ single fallers OR 18.42 (CI: 10.2 – 33.20) Recurrent vs. non fallers only	Calculated from raw data
Stel et al 2003 (142)	Pain over past 4 wk	3 year (P)	OR 1.73 (CI: 1.33-2.24)	Calculated from raw data
Woo et al 2009 (98)	Back pain over past 12 months	12 months (R)	OR 2.26 (CI: 1.71-2.99) Recurrent vs. none/ single fallers OR 2.38 (CI: 1.79 – 3.15) Recurrent vs. non fallers only	Calculated from raw data

Key table 4.3: RR – Relative risk, HR – Hazard ratio, (P) – Prospective ascertainment of falls, (R) – retrospective ascertainment of falls, RaR – Rate Ratio, OR – Odds Ratio, IRR – Incidence risk ratio, PR – Prevalence ratio, LBP – low back pain, Calculated from raw data – unadjusted OR calculated from raw data.

£ - Leveille et al 2002 (51)- Adjusted from discrete time survival analysis (using logistic regression), updating pain level to most recent follow-up interview before event. Covariates included age, race, education, body-mass index, confirmed diseases (hip fracture, angina pectoris, diabetes mellitus, peripheral arterial disease, stroke, Parkinson’s disease), walking disability, fell in 12 months before baseline, Mini-Mental State Examination score, daily use of psychoactive medications, daily use of analgesic medications, gait speed, balance test score, proxy respondent, and follow-up round.

Results considering pain and any fall

Details of the meta-analyses results according to any fall are reported first including subgroup analyses and subsequently followed by the pooled analyses investigating pain and recurrent falls.

Meta-analysis investigating the overall odds of any fall

A global meta-analysis was conducted with 14 studies (11, 51, 98, 121, 134, 153-160) (n=17,926: 5,825 with pain and 12,101 without pain) establishing that pain was associated with a 56% increased odds of falling (OR: 1.56, CI: 1.36 to 1.79, $p < 0.0001$). The data were heterogeneous ($I^2 = 52%$, $p < 0.05$, see Figure 4.2a.). A visual inspection of a funnel plot established one study (153) was at risk of publication bias and was subsequently excluded from all further subgroup analysis (see Figure 4.2b).

Figure 4.2a Global Meta-analysis for all studies investigating the association of pain with falls

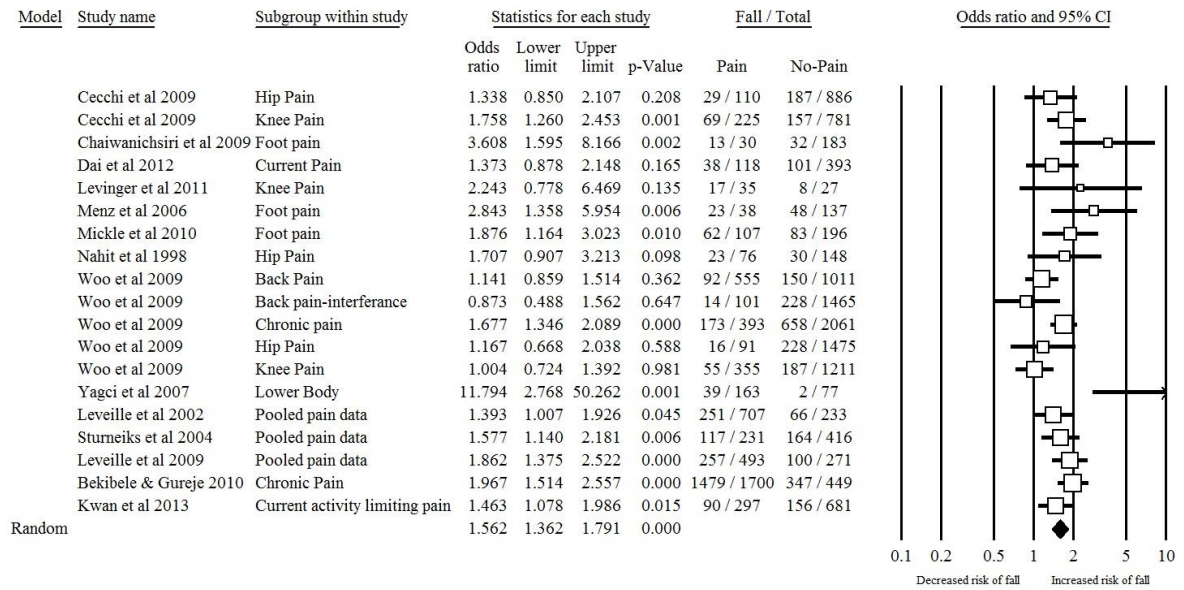
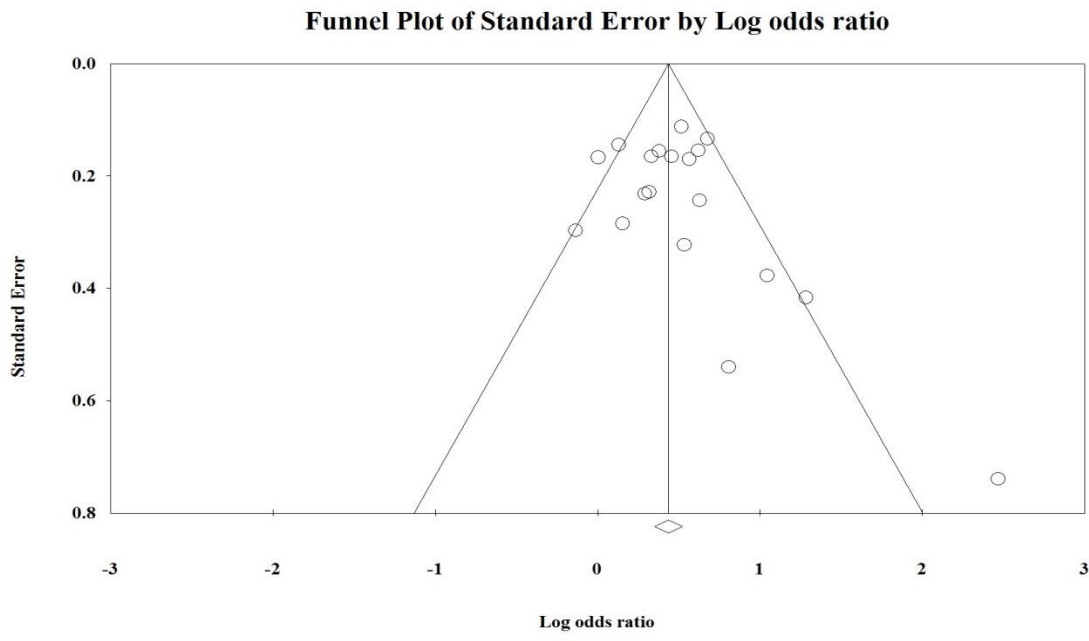


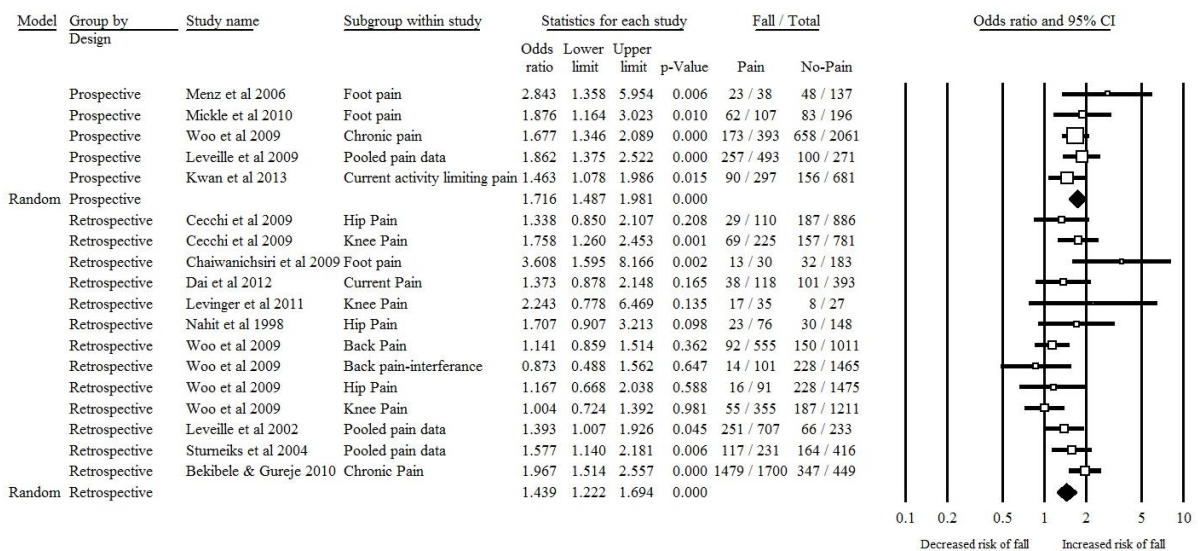
Figure 4.2b funnel plot for main analysis



Meta-analysis of any fall according to the method of falls ascertainment

A meta-analysis with the five studies (n=4,674) that collected falls data prospectively, established that older adults with pain had an increased odds of falling by 71% (OR: 1.71, CI: 1.48 to 1.98, $p < 0.0001$). The data were homogenous ($I^2 = 0\%$, $p = 0.5$). A subgroup analysis was conducted with nine studies (n=13,012) that collected falls data retrospectively and this established the odds of falling was increased by 43% (OR: 1.43, CI: 1.22 to 1.69, $p < 0.0001$). This subgroup analysis was heterogeneous ($I^2 = 49\%$, $p < 0.05$), see figure 4.3.

Figure 4.3 Meta-analysis comparing falls data collected prospectively and retrospectively



Narrative results investigating different pain locations and association with any fall

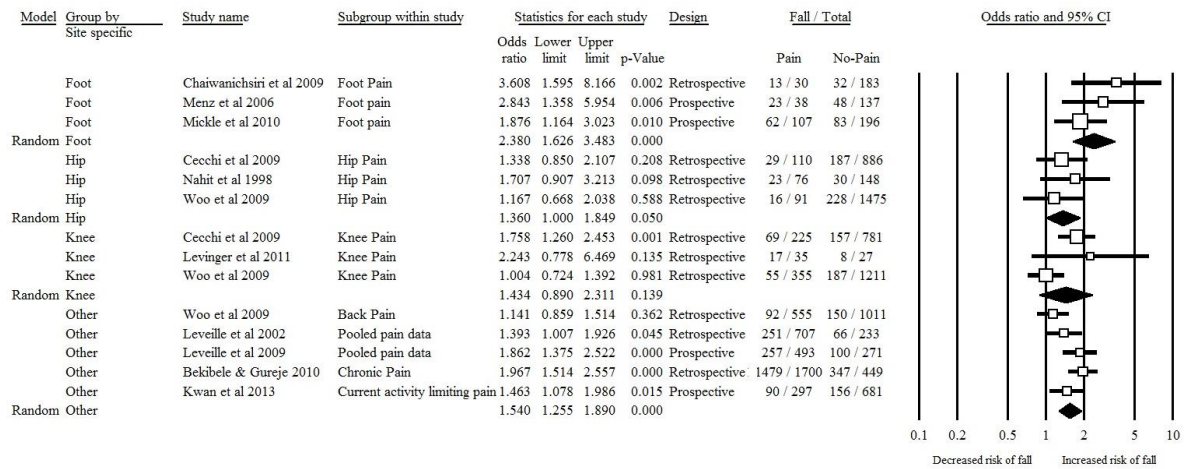
The results of studies looking at single sites of pain and the association with falls showed inconsistent results. For instance, only 2 of the 6 studies that examined falls in people with hip pain found a significantly increased risk for falls (147, 164). Three out of six studies established that knee pain demonstrated an increased falls risk (145, 159, 161), but one study found that this risk was only increased in those recurrent fallers (145). Similarly, three out of five studies (145, 158, 163) demonstrated that back/ neck pain was associated with falls and

two found the risk was particularly increased for multiple falls (145, 163). Three out of four studies established that foot pain was associated with an increased risk of falls ranging from 87% and 260% (155, 160, 166). When looking at ‘body pain’ of an undefined location or mixed pain sites, 6 studies (98, 153, 154, 158, 163, 165) out of seven demonstrated that pain was associated with an increased risk of falls. It was possible to calculate the unadjusted OR calculated for two of these studies (145, 158) and it was within 6% from that reported in the adjusted association reported in each paper. Finally, both studies (11, 51) investigating multisite/ widespread pain established an increased risk of falls. The adjusted association statistics and unadjusted OR calculated from the raw data are presented in Table 4.2.

Meta-analysis investigating any fall and location of pain

A subgroup meta-analysis with 3 studies (145, 159, 161) (n=691) found that foot pain was associated with a 138% increased odds of falling (OR: 2.38, CI: 1.62 to 3.48, $p < 0.0001$). The data were homogeneous ($I^2 = 8\%$, $p = 0.33$). A subgroup meta-analysis with 3 studies (98, 157, 159) (n=2,786) established hip pain was associated with a 36% increased odds of falling (OR: 1.36, CI: 1.00 to 1.84, $p = 0.05$). The data were homogenous ($I^2 = 0\%$, $p = 0.67$). A subgroup analysis with 3 studies (98, 121, 159) (n=2,634) did not establish a significant relationship between knee pain and falls whilst a subgroup analysis of ‘other’ types of pain with 5 studies (total n =6,397) established a 54% increased odds of falling (OR: 1.54, CI: 1.25 to 1.88, $p < 0.0001$, $I^2 = 58\%$, $p < 0.05$). See Figure 4.4 for each meta-analysis.

Figure 4.4 Sub group Meta-analysis investigating location of pain and association with falls



Pain severity and any fall

Each of the 3 studies (11, 134, 162) that investigated the relationship between pain severity and incidence of falls established that the risk of falls was higher as pain severity and its interference with activities increased.

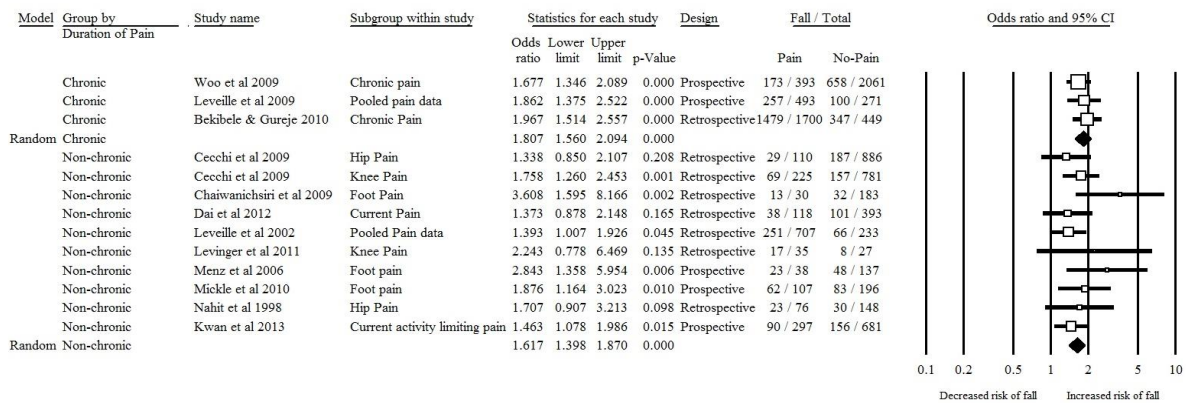
Chronic Pain and any fall

All of the seven studies included (11, 98, 145, 147, 153, 158, 163) established that chronic pain was associated with an increased risk of falls although this was only true for recurrent fallers in three of these studies (145, 147, 163).

Meta-analysis investigating pain duration and any falls

A subgroup meta-analysis with 3 studies (11, 98, 158) (n=5,367) established the odds of falling was increased by 80% with chronic pain (OR 1.80, CI: 1.56 to 2.09, $p < 0.0001$,) and the data were homogenous ($I^2 = 0\%$). A subgroup meta-analysis with nine studies (51, 121, 154-157, 159, 160, 166) (n=5,435) demonstrated that non chronic pain was associated with a 61% increased odds of falling (OR: 1.61, CI: 1.39 to 1.86, $p < 0.0001$, $I^2 = 4\%$ $p = 0.4$). See Figure 4.5.

Figure 4.5 Sub group Meta-analysis investigating the association of chronic and non-chronic pain with falls



Meta-regression analyses investigating moderators for any falls

The meta- regression analyses indicated that the mean age and % of females in each study did not significantly moderate the outcomes of the global pooled analyses ($p > 0.05$).

Results investigating pain and recurrent falls

The overall odds of older adults with pain experiencing recurrent falls

A meta-analysis was conducted with 7 studies incorporating 9,581 older adults (3950 with pain and 5631 without pain) comparing recurrent fallers versus non and single fallers together. It established pain increased the odds of recurrent falls (OR 2.04, CI: 1.75-2.39 $p<0.001$). There was a small amount of heterogeneity in this analysis ($I^2=19.7%$); the forest plot is displayed in Figure 4.6a. A visual inspection of the funnel plots established that no study appeared to be an outlier (see figure 4.6b).

Figure 4.6a Forest plot for pooling of all studies comparing recurrent faller’s vs single/ non fallers

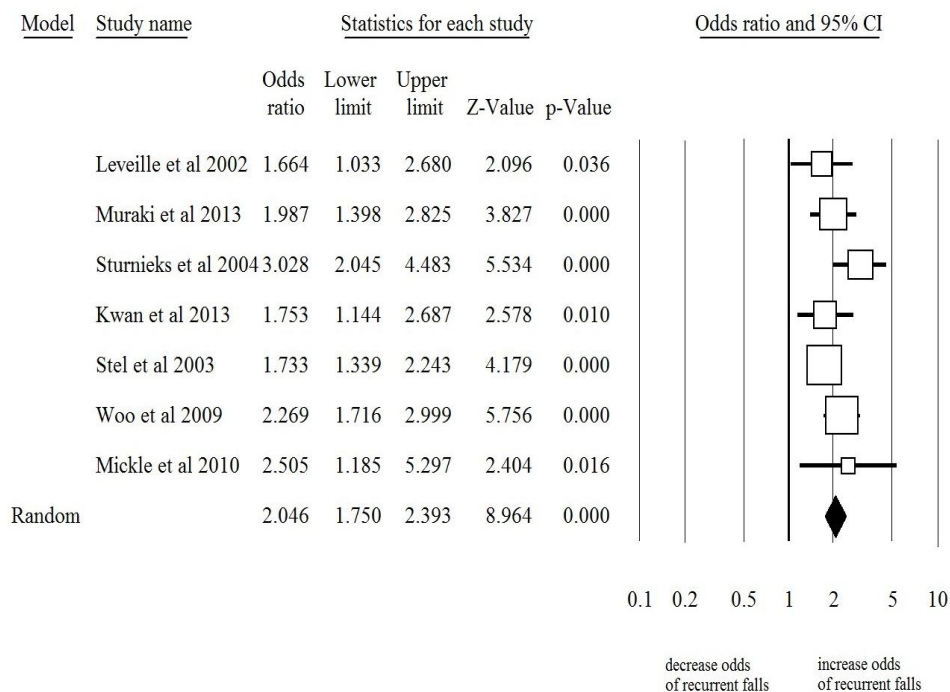
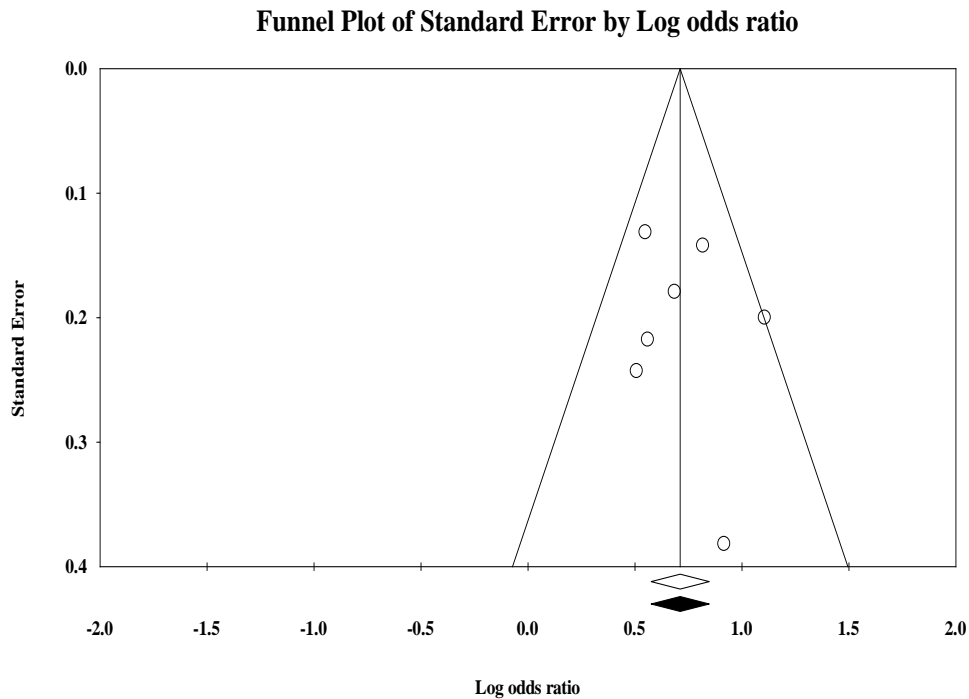


Figure 4.6b Funnel plot of Standard Error for all included studies in main analysis of recurrent falls



From the available data of six studies (51, 98, 134, 146, 154, 166), it was possible to develop 2 X 3 tables to investigate the odds of falling comparing a) recurrent and non-fallers and b) single versus non fallers only. This established that pain was more strongly associated with recurrent falls than single falls (OR=3.05, CI: 1.75-5.31, n =7,418, $I^2=93\%$) although pain was still significantly associated with single falls (OR=2.15, CI: 1.20-3.83, n=7,778, $I^2=93\%$). This analysis is presented in figure 4.7a and 4.7b.

Figure 4.7a Forest plot comparing recurrent fallers vs non fallers only

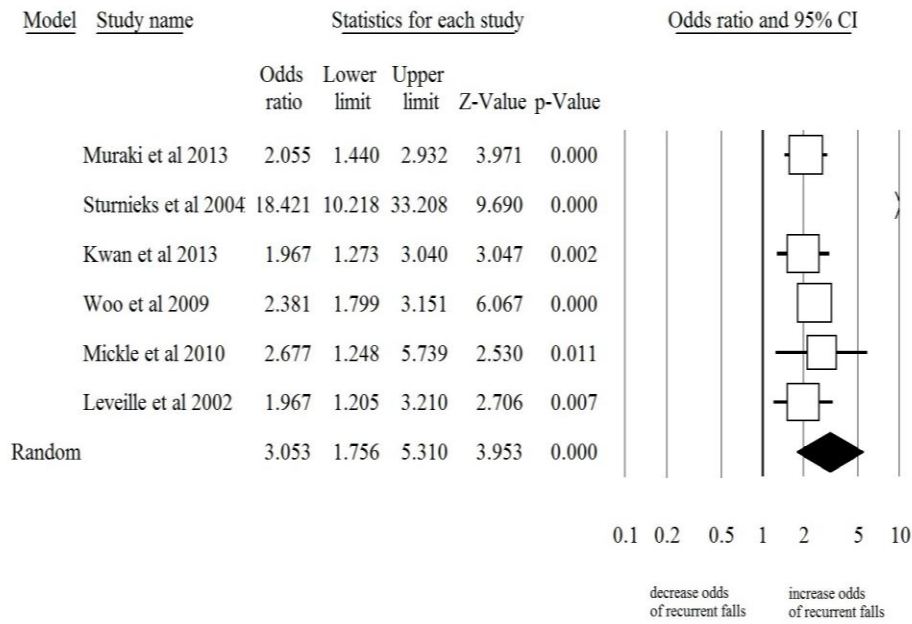
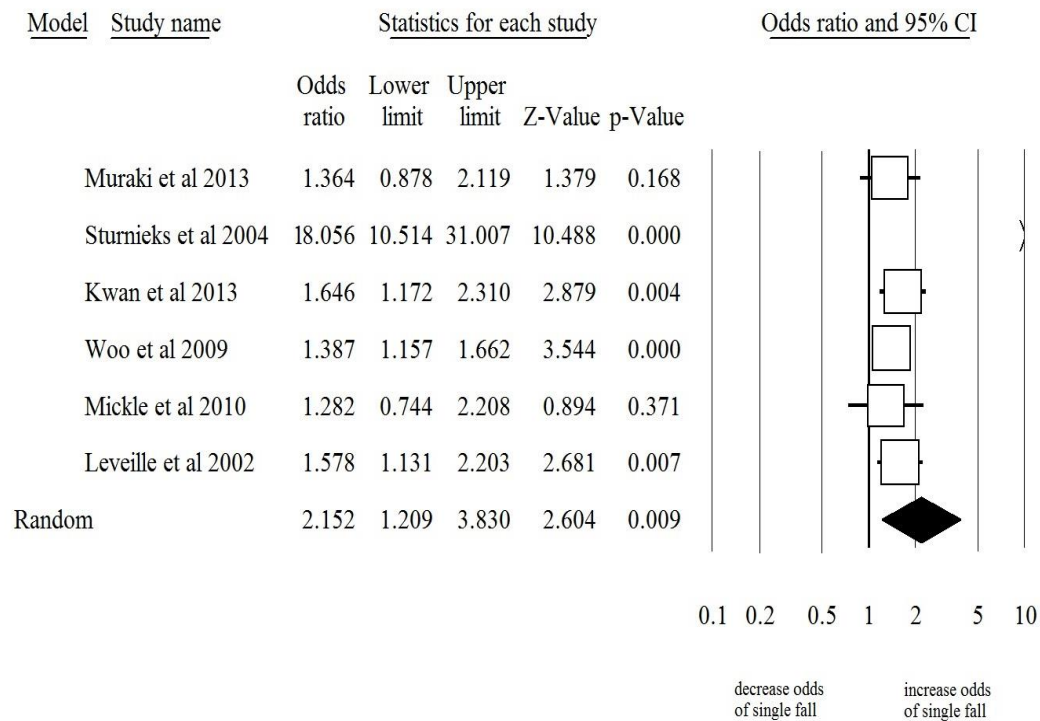


Figure 4.7b Forest plot comparing single versus non fallers only

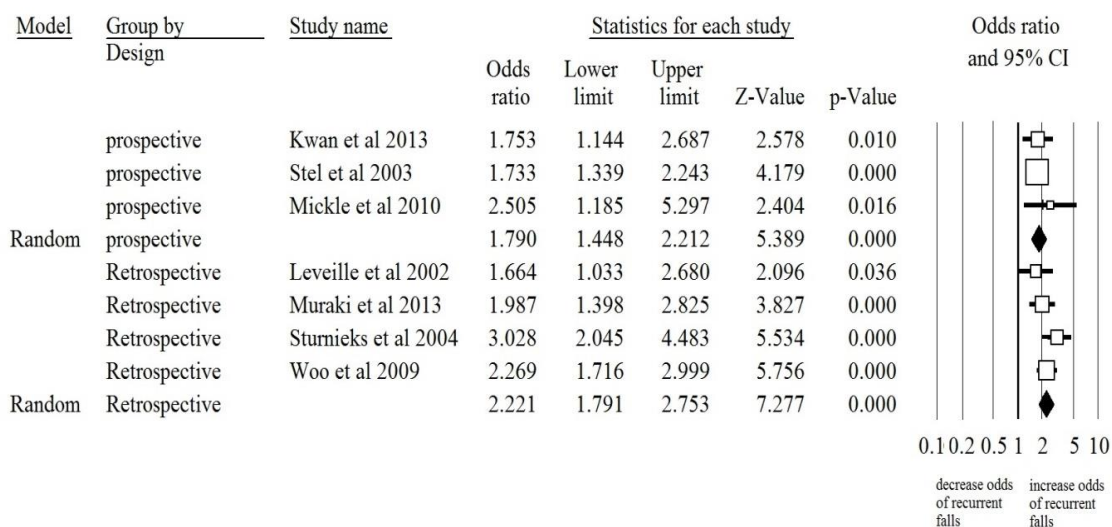


Both of these analyses were heterogeneous and concerns were identified about one study (134) being an anomaly when the results from the 2 X 2 tables were broken down into a 2 X 3 table and it was deemed this study likely increased heterogeneity. Therefore a sensitivity analysis was conducted with this study removed and this established a more moderate relationship between pain and recurrent falls (OR 2.18, CI: 1.82-2.60, n=6,320, $I^2=0\%$) and single falls (OR= 1.44, CI: 1.26-1.64, n= 6,903, $I^2=0\%$) and both were non- heterogeneous.

Pain and recurrent falls and the influence of the method of falls ascertainment

Next, the results for the studies where the falls data were collected prospectively (n=3, (142, 154, 166)) and retrospectively (N=4, (51, 98, 134, 146)) were analysed separately. This established that the odds of recurrent falls were higher for studies measuring falls retrospectively (OR 2.21, CI: 1.79-2.75, $p<0.0001$, $I^2=27.8\%$, total n=6935) compared to prospectively (OR 1.79, CI: 1.44-2.21, $p<0.001$, $I^2=0\%$; n=2646) although both were significant. See figure 4.8 below.

Figure 4.8 Subgroup analysis comparing recurrent vs. single/ non fallers separated by the design of falls collection



The influence of the type, duration and location of pain on recurrent falls

Due to the limited number of studies and heterogeneity in the type, duration and location of pain in each of the studies, it was not possible to conduct any sub group analysis to determine if these had a specific influence upon the relationship with recurrent falls.

Meta-regression investigating moderators of results for pain and recurrent falls

In an exploratory meta-regression analysis it was possible to use the data from three studies (98, 154, 166) to investigate the influence of age and percentage of females upon the observed outcomes of the meta-analysis. For the effect of age on the pain group that experienced recurrent falls, on the effect-size estimate, mixed effect regression slope was -0.043 [Standard Error (SE): 0.041; $P = 0.287$], for the pain no recurrent falls group, the slope was -0.081 [SE:0.076; $P = 0.282$], for the no pain and recurrent fall group, the slope was -0.0906 [SE: 0.0872; $p = 0.298$] and for the no pain and no recurrent falls group the slope was -0.0885 [SE: 0.0819, $p = 0.279$]. In addition, female gender was not related to recurrent falls in the pain group that experienced recurrent falls [Slope 0.0124, SE: 0.0134; $p = 0.355$], the non-pain group that fell (slope -0.0137 , SE: 0.0127; $p = 0.278$), the pain group that did not fall (slope -0.0468 , SE: 0.0468; $p = 0.317$) nor in the non-pain group that did not fall (slope -0.0107 , SE: 0.0238; $p = 0.652$).

4.4 Discussion

The current chapter is the first attempt to systematically review, appraise and meta-analyse the literature investigating the relationship between pain and falls (including recurrent falls) in community dwelling older adults. The meta-analysis investigating the relationship between pain and any falls involved over 17,000 unique older adults and the global meta-analysis established that pain was associated with a 56% increased odds of falling. The subgroup analyses (according to method of falls ascertainment, location of pain and duration of pain) consistently found that pain was associated with an increased odds of falling. In addition, all of the 12 studies within the narrative review which reported an adjusted association statistic demonstrated that pain was associated with increased risk of falling. This review also demonstrated that 50.5% of older adults with pain reported one or more falls over 12 months compared to 25.7% of the control group ($p < 0.001$). This figure of falls is considerably higher than the 30% of community dwelling older adults that fall each year (55).

The results for the meta-analysis investigating pain and recurrent falls incorporated 9,581 unique older adults and established that pain was associated with approximately a 100% increased odds of recurrent falls (OR: 2.04, CI: 1.75-2.39). Subgroup analyses found that the odds of falls although this was higher when falls were measured retrospectively although significantly increased when falls were measured prospectively. Moreover, the subgroup meta-analysis directly comparing recurrent fallers and non-fallers only established that pain was associated with approximately a twofold increased odds of recurrent falls (OR 2.18, CI: 1.82-2.60, $n=6,320$, $I^2=0\%$). This was more pronounced than the available data comparing single fallers versus non fallers only (OR= 1.44, CI: 1.26-1.64, $n= 6,903$, $I^2=0\%$). The annual prevalence of recurrent falls was significantly higher in those with pain (12.9%) than those

without pain (7.2%, $p < 0.001$). However, the number of recurrent falls reported in both the current sample is below the 15% reported in the literature (142). Within the meta-regression analyses mean age and the percentage of females in the samples did not significantly moderate the observed pooled meta-analyses for the pain and any falls and recurrent falls analyses.

A previous review (58) considering over 30 falls risk factors only utilised prospective falls data to avoid reverse causality, which is clearly a consideration for the results where falls were obtained retrospectively. However, attempts were made to negate such concerns by excluding studies where participant's pain was identified from a previous fall. Retrospective recall of falls over 12 months is relatively specific (91-95%) although less sensitive than prospective measurement of falls (167). The result that older adults with pain are 43% more likely to have fallen in the past year is important, since a history of falls is strongly associated with the likelihood of future falls (58, 61) and is commonly advocated as a valid indicator/assessment in clinical practice (57). The current results also indicate a stronger relationship between pain and recurrent falls than a previous meta-analysis (58) that investigated over 30 falls risk factors which reported an OR 1.60 (1.44–1.78). However, it is unclear if the authors of this review (58) used non-fallers only as their comparison group or if they pooled single and non-fallers together. Thus, the association provided in their study is uncertain and did not receive the necessary attention due to its wide scope.

A key aim of the current chapter was to investigate if the pain and fall relationships differed according to the location and duration of pain since this information would provide valuable information to clinicians. The current chapter found that foot pain was strongly associated with any fall ($n=691$, OR: 2.38, CI: 1.62 to 3.4). In addition, hip pain was associated with falls ($n=2,786$, OR 1.36, CI: 1.00 to 1.84) which is in line with the adjusted association statistics reported from large cohort studies that established an increased risk when falls are

measured retrospectively (147) or prospectively (164). Of some surprise was the fact the subgroup analysis found no significant relationship between knee pain and any falls. However, several individual studies reported knee pain is associated with an increased risk of falls when the pain is severe (161) or chronic (145). Regarding the duration of pain, a subgroup analysis with 5,367 older adults established that chronic pain was associated with increased odds of falling by 80% (OR 1.80, CI: 1.56 to 2.09, $I^2=0\%$). This is in line with Leveille and colleagues' (11) study who demonstrated that chronic polyarticular pain was associated with a 70% increased risk of falling. Interestingly, the subgroup analysis for non-chronic pain established the odds of falling was increased by 61% (OR: 1.61, CI: 1.39 to 1.86, $I^2 = 4\%$).

The subgroup analyses found that the risk of experiencing recurrent falls is higher than a single fall. This relationship was evident in all of the 11 studies that investigated pain and recurrent falls. A number of studies within the literature have previously reported that pain is more strongly associated with recurrent falls compared to single falls (145, 163). For instance, Morris et al (163) established that recurrent fallers were more likely to be older females and commonly reported extrinsic risk factors for falls including loss of balance, lack of attention and dizziness. Interestingly, from 1671 responses in their study, no older adults attributed their fall to pain. However, the authors reported that recurrent falls tended to occur indoors rather than outdoors. The first literature chapter (chapter 2) within this thesis demonstrated that older adults with CMP are less active than asymptomatic controls and Morris et al (163) specifically investigated chronic pain in their study (over 12 months). A possible explanation for the increased risk of indoor falls is that older adults experiencing chronic pain reduce their activity and stay indoors due to their pain and hence their risk of indoor falls is subsequently increased. However, a recent meta-analysis (82) demonstrated that physical activity is essential to maintain mobility and independence in activities in daily

living. Previous research has also demonstrated that exercise is effective in reducing falls (59, 168) and also injurious falls (169). Therefore, encouraging older adults with pain to be physically active is likely to be important in maintaining independence and reducing falls. Previously Blyth et al (162) also established that pain was associated more strongly with recurrent falls but did not offer an explanation. It may be that depressive symptoms contribute to the increased falls risk seen in those older adults with pain. Previous research has identified that depressive symptoms are strongly related to recurrent falls (170) and a recent meta-analysis (171) established that Selective Serotonin Reuptake Inhibitors (SSRI) medication is associated with falls and fractures. Moreover, pain is strongly associated with depressive symptoms (17). However, it was not possible to elucidate the influence of depressive symptoms on falls since no study provided this information.

The underlying reasons for the association between pain and falls are likely to be multifactorial, since both pain and falls are in their own right complex phenomenon. Previous researchers (11) have postulated that the mechanisms by which CMP increases the risk of falls may be the result of three possible causes: 1) local joint pathology (e.g. osteoarthritis), 2) the neuromuscular effects of pain and 3) central mechanisms, whereby pain interferes with the older adult's cognition and executive function. Another factor that could possibly contribute is psychological concerns related to falling (FOF, falls efficacy), since these are known to increase the risk of falls in their own right (58) and the previous literature chapter identified these are associated with pain. Moreover, this could be further complicated by self-imposed activity restriction due to perceived mobility limitations (e.g. lower balance confidence) or actual mobility difficulties. Clearly future research is required to further investigate these possible relationships.

Clinical implications

The finding that older adults in pain are at increased risk of falling is important. Adequate pain management is likely to be very important in the older person's rehabilitation and may serve to reduce the risk of falls. The strong association of foot pain with falls advocates the importance of podiatrists within the rehabilitation multidisciplinary team to prevent falls. Previous research has demonstrated that multifaceted interventions delivered by podiatrists to older people with foot pain can lead to a reduction in the rate of falls which is comparable to other well established interventions such as tai chi (172).

The findings of the current chapter may also contribute to key clinical assessment guidelines for clinicians working with people who are at risk of falling or have fallen (e.g. (61)). The presence of pain is clearly an important risk factor that clinicians should routinely assess, specifically because the strength of the association between pain and recurrent falls (OR 2.18, CI: 1.82-2.6) is similar to other commonly well-established risk factors such as increasing age (OR 1.12, CI: 1.07-1.18 (58)), physical disability (OR: 2.42, CI: 1.80-3.26(58)), cognitive impairment (OR 1.56, CI: 1.26-1.94(58)), depression (OR 1.86, CI: 1.26-2.38(58)) and FOF (OR 2.51, CI: 1.78-3.54; (58)). However, it should be noted that these effect sizes were adjusted for age and sex, whilst the analyses in the current chapter were not and the exploratory meta-regression analysis demonstrated that age and sex had no significant effect on the observed outcomes. Therefore, the results have important implications for clinicians working in general older adult services. It is recommended that if an older adult presents at risk of, or has fallen already, the clinician should assess pain and if present, seek appropriate treatment which may include pain management strategies. Previous research (51) has demonstrated that analgesic medication actually lowered the occurrence of falls in older adults with pain, but a more recent study found no such influence (11). This highlights the important role of a pain clinician in the management of falls in older adults. The current

chapter demonstrates that older adults presenting with pain are more likely to have fallen in the past 12 months (OR 2.21, CI: 1.79-2.75) and fall again in the future (OR 1.79, CI: 1.44-2.21). Pain medicine clinicians working with older adults with pain should routinely enquire about their falls history and link in with their local falls service. In general medicine, a single question enquiring about a history of falls over the past 12 months is commonly used as an indicator to identify the risk of future falls (58) and if pain clinicians establish this a referral to a falls service should be made. Unfortunately, due to the limited number of studies and the heterogeneity in the assessment of pain, it was not possible to establish whether certain types (e.g. musculoskeletal pain), sites (e.g. back pain) or duration of pain (e.g. chronic) are particularly associated with an increased falls risk.

Limitations

When considering the results of the chapter, it is important that a number of limitations are noted which provide key direction for the primary data collection of the thesis. First, it is not possible to rule out reverse causality for the studies that measured falls retrospectively. However, every attempt to negate this was made by excluding studies whereby pain was identified from a previous fall. In order to further attempt to reduce this risk, separate analyses comparing falls data measured retro- and prospectively were conducted and established a small difference. Regardless, retrospective history of falls is strongly associated with future falls and is routinely used to identify those at risk of future falls (58). Second, there was considerable heterogeneity in the assessment and classification of pain within the studies included, making it impossible to conduct separate subgroup meta-analyses. Third, unadjusted OR for the meta-analysis were used since it was not possible to consistently adjust for other known falls risk factors. In reality, falls are often multifactorial (138) and it is likely that if it was possible to consistently adjust for known risk factors a more accurate association between pain and recurrent falls would be established. In addition, because most of the

studies primary aim was not to investigate the association between pain and falls (and in particular recurrent falls) it was not possible to consistently adjust for age and gender in the analysis. However, meta-regression analysis demonstrated from the available data that these had no influence on the observed results. Therefore, using unadjusted OR may have slightly inflated the results found in the current chapter. Another limitation is that due to the paucity of available data on mean age and gender it was not possible to stratify the results according to age groupings (e.g. <65 , 65-79, 80+) and sex. Despite this fact, the results from single studies were emphatically unanimous and all found that pain was consistently associated with a significantly increased risk of recurrent falls. Fourth, the researcher attempted to reduce the heterogeneity of the participants included, for example excluding neurological and conditions whereby cognition is likely to have been impacted, but the number of comorbidities in each sample was not consistently reported. Whilst this may have focussed the results of the current chapter, it may have possibly narrowed its clinical relevance.

The current systematic review and meta-analyses have shed new light on the relationship between pain and falls in older adults. A number of limitations in the current literature have been identified which provide important guidance for the primary data collection in the thesis. For instance, few studies included in the review specifically set out to investigate the relationship between pain and falls and no single study to date has had the primary aim to investigate the relationship between CMP and recurrent falls. This exemplifies the low consideration given within the literature investigating pain and in particular CMP as an independent risk factor for falls. Moreover, the assessment and definition of pain has varied widely and only one study (11) has clearly defined and assessed CMP in accordance with recognised pain assessment guidelines such as the recently published British Pain Society guidelines (13). Therefore, future research is needed that clearly assesses the location, duration and severity of pain in older adults and falls ascertained prospectively for 12

months. Previous research has indicated that multisite pain (pain occurring at two or more sites) may be a particular risk factor for falls (11). However, it was not possible to systematically assess this in the current available literature and only one author has attempted to look at the impact of multisite pain on falls but not recurrent falls (11). Another major limitation in the research to date is that 9 studies (43%) did not provide a definition for a fall, this is concerning but consistent with previous research in the wider falls literature (151). Of those that did provide a definition for a fall, a range of differing definitions were employed. Standardisation in the definitions employed within research is essential to enable replication and also to enhance quality of research thus enabling meta-analyses to be completed. The PROFANE European falls network (56) offers an excellent comprehensive falls taxonomy that ensures continuity and consistency in research investigating falls. Given these limitations, future research is clearly required to prioritise the investigation of the relationship between clearly defined CMP and recurrent falls in particular. Moreover, there is a need to try and disentangle the relationship between the number of pain sites and falls risk. Future research should therefore establish if older adults with multisite pain are at more risk than those presenting with single site pain. The use of a pain screening measure may also be useful in establishing those older adults at greatest risk of falls. Therefore, future research should seek to investigate whether a pain assessment scale can correctly identify those most likely to falls in clinical practice.

4.5 Summary of chapter

In conclusion, the findings from the current chapter demonstrate that pain is associated with falls and in particular recurrent falls in community dwelling older adults. Of particular interest are the findings that the risk of falls appears to differ according to the site of the bodily pain with the greatest risk found in those with foot pain. Moreover, the relationship between pain and recurrent falls appears to be stronger than pain and single falls. The findings within this chapter already hold important clinical relevance. However, notable limitations in the literature to date are evident. For instance, few authors have clearly defined CMP and no author has set out with the primary aim to investigate the relationship between CMP and recurrent falls. Deficits were also noted in the fact that a large proportion of studies failed to define a fall and there is a lack of clarity regarding the risk of falls in those with multisite pain. Given the aforementioned, future research within this thesis should explore the relationship between clearly defined CMP and recurrent falls. Future efforts should investigate if the risk of falling differs according to the number of pain sites, for instance comparing the risk of falling in those with single and multisite versus those without CMP.

4.6 Summary of the literature review chapters, aims and hypothesis

The three literature chapters have been the first systematic reviews investigating the relationship between pain and physical activity/ sedentary behaviour (chapter 2), pain and psychological concerns related to falls (chapter 3) and pain and the risk of falls (chapter 4) respectively. Each chapter has provided a detailed, methodical appraisal of the available literature in an attempt to begin the process of answering the research aims for the thesis. Moreover, the methodological and systematic appraisal of the current literature enabled gaps and limitations to be identified and built upon in planning for the primary data collection for the thesis. Given this appraisal, nine specific research questions have been developed under the three primary and two secondary research aims, which will be answered within the primary data collection from the remaining parts of the thesis. The research questions were devised to ensure that they would be adding to the body of knowledge and would therefore warrant publication and be at the forefront of the academic discipline (all key FHEQ criteria). Specifically the research questions under each results chapter include:

Sedentary Behaviour (Chapter 7) (primary aim 1)

- 1) Are older adults with CMP more sedentary than people without CMP of similar age and sex without CMP?
- 2) What factors contribute to the sedentary behaviour among older adults with CMP?

Falls and recurrent falls (Chapter 8) (primary aim 3)

- 3) Are older adults with CMP more likely to experience a) any (≥ 1), b) single and c) recurrent falls than a comparison group without CMP.
- 4) Are there difference in the odds of older adults with CMP experiencing a) any (≥ 1), b) single and c) recurrent falls between those with single and multisite pain compared to the comparison group?

- 5) Can the BPI be used to discriminate between non-fallers and a) any falls (≥ 1) and b) recurrent fallers in older adults with CMP?

Psychological concerns related to falls (chapter 9 and 10) (primary aim 2)

- 6) Does pain interference contribute to each of the four common psychological concerns related to falls after the adjustment for established risk factors previously identified in the literature?
- 7) Is musculoskeletal pain severity or the number of CMP sites associated with balance confidence in community dwelling older adults?

The impact of mobility limitations on HRQOL (chapter 11) (secondary aim 4)

- 8) What is the prevalence of CMP and how is this related to HRQOL and in particular what is the contribution of mobility limitations and falls related factors to this?

Older adults with CMP experiences (chapter 12) (secondary aim 5)

- 9) What are the experiences of a convenience sample of older adults with CMP towards physical activity/ sedentary behaviour, psychological concerns related to falls and actual falls?

Each research question is addressed within the ensuing chapters. However, before primary data collection occurs, it is essential that the researcher sets out their world view and philosophical underpinnings of their research. Therefore, the next chapter is devoted to an exploration and critical discussion regarding research approaches and philosophical underpinnings.

CHAPTER 5

METHODOLOGY CHAPTER

Overview of the chapter

This chapter provides a rationale for the chosen methodology and research methods to answer the primary and secondary aims of the thesis. Within this, the researcher provides a critical overview of the different worldviews (paradigms) and their encompassing philosophical components, research approaches and ultimately justification of the approach taken to answer the research questions developed from gaps within the scientific literature.

Philosophical worldviews: Setting the Scene

All research regardless of whether or not the researcher is aware of it, has a philosophical foundation by which the researcher makes enquiries and gains knowledge (173, 174). These philosophical underpinnings or worldviews, consist of a set of basic beliefs or assumptions that guide the researcher's enquiries and orientation about how they view the world and thus approach their research (174, 175). Kuhn (176) developed the word paradigm stating this is a set of beliefs, generalisations and values of a community of specialists. More recently, Creswell (63, 174, 177) has advocated the term worldview over paradigm, stating this is more encompassing to those who may or may not be associated with a specific discipline or community of scholars. Given the inclusivity and acceptance of the term worldview, this term is used henceforth within the thesis.

What are worldviews and why do they matter?

In order to understand worldviews, it is necessary to consider their two fundamental component parts i) ontology and ii) epistemology (178). Ontology refers to the researchers beliefs about the nature of reality, whilst epistemology refers to the relationship between the 'knower' and the 'known' (178). Lincoln (179) states that worldviews '*tell us something about the researcher's proposed relationship to Other(s). They tell us something about what the researcher thinks counts as knowledge...They tell us how the researcher intends to take account of multiples and contradictory values she will encounter*'.

Social scientists and those aligned with qualitative research are particularly ardent enthusiasts of worldviews and firmly believe that worldviews are of utmost importance since they govern and influence all research processes and is therefore central to developing the aims of research (178). However, some researchers and in particular those from applied clinical backgrounds, typically adopt a more pragmatic approach to research (180). For instance,

researchers from applied healthcare backgrounds often believe that research aims and methods are driven by problems observed in practice and not solely by abstract theoretical underpinnings (180). This point is highlighted by Brannen (181) who argued that *'the practice of research is a messy and untidy business which rarely conforms to the models set down in methodology textbooks. In practice, it is unusual, for example, for epistemology to be the sole determinant method....there is no necessary or one to one correspondence between epistemology and method'*.

However, whilst these two views appear to be polar opposites, it is important that a balance is struck wherever the researcher considers their standpoint on this spectrum as they set out their worldview. The reality of most research is that many philosophical assumptions are hidden and most publishing authors do not acknowledge their 'stance' through a critical discussion (65, 178). However, a journey of critical discussion is essential and it is the aim of the current chapter to critically justify the worldview and research methodology through an exploration of the two main research approaches (quantitative and qualitative) and their constituent philosophical underpinnings.

An introduction to qualitative and quantitative research

There has been an intense debate for many years regarding worldviews and the two common research approaches (182). Quantitative researchers typically adhere to the positivist worldview whilst qualitative researchers align themselves to the constructivist or interpretivist view of the world (177, 178). Purists at each end of the spectrum often believe that the two approaches are so paradigmatically different, researchers must pledge allegiance to one or the other (182). This rigidity has been questioned by some within applied healthcare settings (180) including physiotherapy (183), where there is a need to utilise methodological diversity and flexibility to understand complex phenomenon. The reality is

that there are multiple advantages and limitations to both approaches and these will now be explored through a critical lens.

Quantitative Research and positivism

Quantitative research is most often associated with the positivist worldview, which is underpinned by the belief that reality exists as an external phenomenon and can therefore be understood by empirical research. Whilst the fundamentals of positivism have existed for several centuries, the term positivism became well recognised after it was used by Comte (184) who argued that scientific knowledge could be ‘positively’ applied to drive technical and medical progress and positively applied to society and policy making (185). From a positivist view, knowledge is attained through gathering facts (often numerical figures), that provide the basis for laws and theories upon which hypotheses can be tested (186). The basic underpinning assumptions are that there is an objective reality (Ontology) which is singular in nature. Positivist’s epistemological stance is a commitment to scientific realism whilst testing hypothesis through empirical methods in which the researcher attempts to maintain distance and impartiality, thus seeking to minimise bias (174, 185). The most common objectives are to describe, understand and predict in studies which are conducted under controlled conditions in order to isolate the causal effects of single variables thus attempting to understand ‘pure’ relationships. Naturally, such theory applies well to laboratory settings, but in applied healthcare settings, such control is clearly not feasible nor possible. Quantitative researchers seek to make claims about the generalisability of their findings since large numbers are typically investigated within this approach (187). Positivists typically follow a cause and affect model which often includes the hypothetico-deductive method (185). Within this approach, the researcher follows deductive reasoning and develops theory based on knowledge and tests hypotheses from it, usually is a process of seeking to verify hypotheses rather than falsify them (180). However, some may employ a falsifiability

approach whereby a researcher uses a similar approach to try and discredit or disprove a hypothesis and theory (188).

Within healthcare settings, the use of outcome based quantitative investigations has been predominant approach for some time, but it is important to note that this has its limitations (186, 189). One major criticism is that quantitative researchers view the world through a narrow lens, only focussing on a few variables at any one time and this is an oversimplification of the complex nature of human lives, societies, cultures and health (178). Moreover, human beings have feelings, attitudes and emotions and it is very difficult to capture and fully understand an individual's subjective perceptions about their health through adopting a purist quantitative approach (189). Whilst the testing of controlled variables in pursuit of internal validity (often at the expense of external validity) may be feasible in laboratory settings, clearly their application in the investigation of people's functioning in society is an oversimplification and not feasible. This point is elucidated by Sale (190) (page 44) who states that '*quantitative methods cannot access some of the phenomena that health researchers are interested in, such as lived experiences as a patient, social interactions, and the patients' perspective of doctor-patient interactions*'. In addition, whilst quantitative research makes claims about eliminating/ reducing bias, some have argued it is not possible for a researcher to remain completely impartial from their work (191). For instance, even if a researcher was involved in a double blind RCT, at the point at which they write the manuscript, they are un-blind and will have an agenda that may influence the writing up of the manuscript. These criticisms of the positivist approach led to the more flexible post-positivist movement which is a more pragmatic application of quantitative research. Post positivists believe like positivists believe that reality exists and can be studied but that reality can never be fully understood (175).

Putting quantitative research in the frame for the PhD

To date, quantitative research approaches have been favoured in the literature investigating CMP and the outcomes of interest for the PhD and this has advanced our understanding. However, the three systematic review chapters undertaken established a number of methodological and practical shortcomings and limitations in the research to date and in recognition of these ‘gaps’, the specific research questions for the thesis were established. Clearly in order to answer the primary research aims and subsequent research questions, a quantitative approach is most suitable since it is not possible to use qualitative methods to make statistical inferences regarding the association between CMP and sedentary behaviour, and between CMP and psychological concerns related to falls and actual falls. The development of the specific research questions will be explored briefly with reference to the literature.

Using quantitative research to investigate sedentary behaviour in older adults with chronic pain (chapter 7, primary aim 1)

Within the first systematic review chapter (chapter 2), it was established that no author had investigated the relationship between CMP and sedentary behaviour. In addition, the chapter demonstrated that the assessment of pain was not consistent with recommended pain assessment guidelines (13). Moreover, the correlates and predictors of sedentary behaviour are also not known in this population and in particular the relationship with psychological concerns related to falls. The findings from the systematic review chapter provide sound rationale for the first study within the PhD (chapter 7) which will establish if older adults with CMP have more sedentary behaviour compared to the comparison group without CMP. In addition, the secondary aim will benefit from quantitative research in order to determine

the factors that may contribute to the increased sedentary behaviour among older adults with CMP.

Using quantitative research to investigate the relationship between musculoskeletal pain characteristics and psychological concerns related to falls (chapter 9, primary aim 2)

The second systematic review chapter (chapter 3) established that no author had set out with the primary aim to investigate if older adults with CMP are more likely than those without CMP to experience psychological concerns related to falls. The only two studies included within this chapter that did investigate this, had small sample sizes (both <40) and only measured one of the four commonly regarded psychological concerns related to falls. Psychological concerns related to falling are highly prevalent in the general older adult population and can impact an older person's quality of life and increase their risk of actual falls (133). Since both CMP and psychological concerns related to falls are highly prevalent and problematic, the second aim for the thesis was established to determine if older adults with CMP experience more psychological concerns related to falls than an asymptomatic comparison group (presented in chapter 9 and 10). Within the wider literature (43) quantitative methods have been successfully utilised to investigate these phenomena and are appropriate for the second study within the thesis. Quantitative enquiry will also enable the correlates and predictors of each of the four main types of psychological concerns related to falls to be explored. Quantitative research will enable the investigation of the influence of musculoskeletal pain characteristics on each of the psychological concerns related to falls, whilst adjusting for several covariates which have already been identified in the literature to influence these. Clearly quantitative research is required to address the research questions stemming from the systematic review chapter.

Using quantitative research to establish if older adults with chronic musculoskeletal pain are more likely to fall (chapter 8, primary aim 3)

The third systematic review chapter (chapter 4) highlighted a number of methodological shortfalls within the literature investigating pain and falls in older adults. First, most researchers did not define an actual fall. Second, the assessment of pain was inconsistent with recognised guidelines (13). Only one study has assessed CMP and investigated the association between CMP and falls (11). However, this research did not investigate the relationship of chronic pain and recurrent falls, which is a particularly high risk group for experiencing the adverse consequences of falling and research priority. The third systematic review chapter also identified the association between pain and recurrent falls appears to be more pronounced than single falls. However, no authors have clearly defined CMP and set out with the primary aim to investigate the relationship between CMP and recurrent falls. Within the wider falls literature the use of quantitative research has led to more effective interventions being developed (55) and it is deemed the most suitable method to address the third primary aim of this thesis within the third study (presented in chapter 8).

Limitations from a purist quantitative approach

Whilst adopting a quantitative approach is suitable to answer the primary research aims and subsequent research questions, it may not enable context and an in-depth exploration of the relationships from the perspective of the individual outside of the outcome measures that will be employed. Obtaining an in-depth exploration of the individual's perspective of a health issue is important and commonly used by physiotherapists and other healthcare professionals when enquiry is made during routine assessments. Previous authors (189) have suggested healthcare researchers should consider qualitative methods when the researcher is attempting to generate data necessary for a comprehensive understanding of a problem or to gain insights

into potential causal mechanisms. In recognition of the potential limitations from adopting a purist quantitative approach and the potential to provide a wider understanding by integrating qualitative research methods into the PhD, the author will critically consider the role and value of qualitative approaches within the aims of this thesis.

Qualitative Research approaches: a different view of the world

Qualitative research adopts an alternative approach, using a wide and deep angle lens to look at human choices, behaviour and health (187). Qualitative researchers focus on subjective meaning and seek to explain people and their behaviour in greater depth whilst obtaining context (178). Qualitative researchers are typically ardent advocates of the interpretivist or critical worldviews and are interested in understanding how people think and interact (187). The ontological views of qualitative researchers are typically subjective, personal and socially constructed whilst the epistemological view is one of relativism (187).

A key strength of qualitative enquiry is that it considers people in their natural environment as opposed to some modern day quantitative enquiries, such as the placebo randomised controlled trial where conditions are often abstract and artificial. However, the converse argument can also be proposed, whereby as one increases external validity, internal validity is compromised. Another key distinguishing feature evident is within the sampling approach used in qualitative research, where researchers will use a purposive sample (178). Numerous authors (178, 186, 191) have stated it is an unfortunate consequence that qualitative research is contrasted against quantitative research but it can be distinguished because it is interested in the complexity, breadth and context of phenomena and not prevalence, estimates and effect sizes (189). When designing studies, qualitative researchers are flexible and use circular designs instead of ridged, predefined linear protocols through sampling, data collecting, interpretation and analysis (178). In addition, the researcher typically works from the bottom

(inductive) whereby they collect data, interpret it and later on develop hypotheses or theories as opposed to statistically testing a hypothesis (189). Within recent years researchers have advocated the use of qualitative research in traditional biomedical orientated territories such as cardiology (189), physiotherapy (178) and psychiatry (192).

Whilst qualitative research has clear advantages, there are some criticisms of this approach. The most common being its apparent lack of rigour, reproducibility and generalisability (186) and some authors have harshly referred to it simply as an assembly of anecdote and personal impressions that is strongly subject to researcher bias (193, 194). In addition there are concerns with the small numbers of people utilised in qualitative research and lack of a random sampling (186) and concerns about the lack of criteria by which qualitative research can be judged (191). However, there are clearly questions that a qualitative research approach can answer and it has an important place within the PhD. Therefore, a brief overview and critical discussion of the main types of qualitative research will be undertaken before the author outlines the method chosen.

Overview of Qualitative approaches

A number of approaches are available at the disposal of the researcher under the umbrella of qualitative research. However, the most common qualitative methods within applied healthcare include ethnography, grounded theory, narratives and phenomenology (63, 177, 186). Each will now briefly be explored before the author outlines the qualitative approach that will be taken to meet the secondary aims of the thesis.

The grounded theory approach was originally developed by Strauss and Corbin (195) and is a strategy whereby the researcher derives theory through the process of research which is grounded in the views of the participants (174). The process involves multiple stages of data collection and refinement and the two most common categories are constant comparison and

theoretical sampling of different groups (65, 174). Grounded theory is synonymous with generating theory from data (178). This approach is not useful to address the aims of the thesis since theory has been established from the literature review chapters and theory/hypotheses have already been developed. Previous research (196) has adopted a grounded theory approach to provide information for interventional work in pain in older adults. Whilst this approach is clearly valuable, the qualitative work in this thesis will seek to compliment the quantitative findings and not generate new theory to inform quantitative work.

Ethnography refers to a strategy of enquiry in which the researcher studies interactions with a particular cultural group over a prolonged period by collecting data within the natural setting through observation and interviews (63, 65). An ethnographic approach has been taken to investigate physical activity and falls program engagement in ethnic minorities (197). However, its use within this thesis is limited since the aims are not to interpret particular cultural experiences of physical activity, psychological concerns related to falls or actual falls. Narrative research is the process by which the researcher studies in depth an individual or group of individual's stories (174, 178). It is useful to collect stories so that researchers can generate deep insights into people's experiences, sense of self, emotions and the world (178, 198). Whilst this approach could be considered, it focuses on greater depth and in particular an individual's life story and does not typically enable focused in depth exploration. The purpose of the qualitative research in the PhD is specific and does not warrant in-depth narrative storytelling.

Lastly, phenomenological research is the strategy of enquiry where the research identifies the participant's experiences about a particular phenomenon being explored (174). Within a phenomenological approach, the researcher remains impartial and 'brackets' their own experiences and beliefs to better understand and focus on the participants experiences of the

phenomenon (174). Phenomenology is the most appropriate approach for this thesis, since it will enable the researcher to focus on an individual's experiences of how CMP affects physical activity, psychological concerns related to falls and actual falls (i.e. the phenomenon being explored).

Why a qualitative approach will be beneficial

There is a relative paucity of qualitative literature investigating physical activity, psychological concerns related to falls and falls in older adults with CMP. Whilst the primary aims lend themselves to quantitative enquiry, qualitative research would be highly valuable and complementary to supplement the findings from the quantitative methods. In particular it would enable context to be placed within which any observed relationships occur and will enable the exploration of 'how' and 'why' particular relationships exist (183). Therefore, a pragmatic mixed methods approach is required and this will briefly be explored and justified.

Mixed methods research: Pragmatism

The above discussion highlighted there are multiple benefits and limitations associated with adopting a solitary quantitative or qualitative approach. When one approach alone is unable to provide a rounded answer, there is sound justification to combine the two approaches to answer complex research questions or understand phenomena (178, 183). Mixed methods research has been posed as the third paradigm, sitting along the continuum between purist qualitative and quantitative endeavours (64, 199). A range of philosophers and sociologists have reported on a diverse variety of intellectual rationale for mixing qualitative and quantitative research (187). However, a straight forward reason was given recently (64) where the authors state that within a mixed methods approach, researchers purposefully integrate and combine both types of data to maximise the strengths and minimise the weaknesses of each approach. A mixed method approach is becoming increasingly popular in applied healthcare research since it enables the cross validation of results across the two approaches whilst offsetting the limitations of each approach on its own (183). Indeed there is evidence regarding its successful use in a range of healthcare settings including cardiology (189), mental health (64) and physiotherapy (183, 199).

Whilst it is clearly evidently that combining two approaches to enhance a research project is a creative and positive way to answer a research question, there are some critics to this approach. Most criticism stems from purists at each of the spectrum and centres on the argument that the two approaches are so paradigmatically different it is difficult to successfully mix each within one study (178, 190). In addition, others have expressed concerns that some researchers adopt a mixed methods approach with little consideration of worldviews and underlying assumptions and fail to engage in a critical discussion (178, 190). In order to address this, the author will engage in a critical discussion by describing various worldviews typically considered within a mixed methods approach, leading to the author

outlining their worldview and how this relates to the primary research design. The critical discussion will follow the outline of Smith and Caddick (178) pioneers of critical discussion of social science research methods in a number of health related fields including physiotherapy.

Worldviews within mixed methods approaches

Within mixed methods research, a number of worldviews have been adopted including post-positivism, interpretivism, critical realism, and pragmatism (178, 186) and each will briefly be explored.

Post-positivism consists of a worldview whereby the researcher responds to the ontological questions by adopting subtle realism and epistemological questions by adopting an objectivist epistemology (178, 186). Creswell and Plano-Clarke (174) state the ontological beliefs of the post-positivist are that there is a singular reality, with researchers rejecting or accepting hypothesis in a deductive manner and their epistemological stance is from a distance and impartial. Smith and Caddick (178) agree and acknowledge that post-positivists believe reality is out there driven by natural laws and mechanisms that can never be fully apprehended and only approximated which is in contrast to positivists who believe reality is knowable. Within an objectivist epistemology, the underlying assumption is that the researcher and the researched are independent from one another and importantly that the researcher is able to conduct the research without influencing the outcomes (178, 186). The researcher uses standardised measures and eliminates sources of bias wherever possible and ensures that the results are replicable (178, 186).

Interpretivists contrast post-positivists on several fronts (174). Firstly, interpretivists subscribe to a subjectivist and constructivist epistemology (178). In addition, their ontological assumption is that social reality is multiple (174). Interpretivists also differ in

their route of enquiry since it is a matter of interpretation with the researchers attempting to focus on ways people construct meanings about a phenomenon (178).

Critical realism is similar to the post-positivism approach to ontology since researchers believe the real world is out there and we can come to know it (200). Where critical realists differ from post-positivists is the fact they view the world as being socially constructed (200) and therefore they subscribe to subjectivist and constructionist epistemology meaning it is not possible to segregate the researcher from the researched (178). Lastly, critical participatory enquiry adopts the constructionist epistemology and they seek to provide knowledge to engage with social structures (64, 65, 178).

The most commonly adopted worldview by mixed method researchers and in particular those in applied healthcare, is pragmatism. Pragmatism is a philosophy that attends to the practical nature of reality, finding truth in the solutions of problems and the consequences of objects and actions (201). Pragmatism is underpinned by the notion that researchers use ‘whatever works’ and both objective and subjective knowledge is valued (64, 65, 186, 201). The pragmatic worldview is summed up by Creswell and Plano-Clarke (174) (page 11) *‘pragmatism opens the door to multiple methods, different worldviews, and different assumptions, as well as different forms of data collection and analysis’*.

The roots of modern day pragmatism lie with John Dewey and remain prominent within applied healthcare settings where research is driven by problems observed in practice (201-203). Pope and Mays (186) state that pragmatism is favoured by clinicians, because they observe a practical problem in action and attempt to address that as opposed to fitting a worldview to their practice. Thus, the greatest determining factor when choosing research methods is not worldviews and theoretical leanings, but the observations at the forefront of their consciousness they observe within their reality. However, worldviews and theoretical

leanings may come to the forefront at a later stage when a researcher becomes awoken to this. Tashakkori and Teddlie (204) state metaphysical talk (ontology) should also be disregarded and that a practical research philosophy should guide methodological and research method choices. Pragmatism is gaining popularity in physiotherapy (183, 201) and pragmatists rationalise that the paradigmatic differences deemed incommensurable by some can be overcome (178). Smith et al (178) (page 378) sum up the views of pragmatism within the context of physiotherapy and state *'for pragmatists, the basic differences between paradigms are deemed commensurable. As a consequence, the epistemological and ontological differences between paradigms do not really matter. What matters for proponents of a pragmatist position instead is the purpose of the research and the methods used to meet it.'*

Pragmatic worldview for this thesis

The author's worldview is akin to pragmatism since there is a practical problem that was identified by gaps within the literature and this has been the major determining factor in developing research aims, research questions, methodology and research methods. The main criticism pointed at researchers adopting pragmatism within mixed methods research is that authors fail to engage in critical discussion and avoid talk of theoretical underpinnings and fail to justify their choice. The above discussion attempted to address this. In conclusion the authors' view within an overarching pragmatic framework is largely in line with the post-positivist worldview that there is a single reality (for example, older adults with CMP either are or they are not more likely to fall over than those without pain) which can be tested through empirical means and the hypotheses set can be accepted or rejected. However, this is still a pure look at the research question. Nevertheless, the researcher is set on obtaining this knowledge in an impartial manner and is attempting to ensure the results are generalisable and every attempt will be made where practicably possible to reduce the risk of bias. However, whilst undertaking the above critical discussion the author acknowledges the

limitations of a purist quantitative approach and values the use of explanatory qualitative research to explore the main quantitative findings with a convenience sample with CMP. Naturally, it is not possible to commit to one purist worldview in conducting this research, but the researcher will predominantly adopt a post-positivist approach whilst also engaging in some exploratory qualitative research that is more akin with an interpretive worldview. Thus, in order to address the multiple worldviews a pragmatic worldview is suitable within the mixed methods approach undertaken in this thesis. In summary, the defining features of a pragmatic worldview include (63-65, 174):

- The researcher has the freedom of choice, they choose the methods, techniques and procedures to best address the aims of the research.
- The research question is the primary factor when considering what and how to conduct research.
- Researchers may utilise aspects of different worldviews so long as the aims of the research are addressed.
- Pragmatic researchers look to different types of research approaches to collect data (quantitative and qualitative). The researcher looks at the what and how to research based on the intended consequences or scientific/ practical justification.
- Truth is what works at one time and there may be one or more truths. Thus, within a mixed methods approach, the researcher uses both quantitative and qualitative research because together they can provide a better understanding of the problem.

Developing and choosing a model for mixed methods research

Once a researcher has established a mixed methods approach is suitable, it is essential they consider and employ the most appropriate model as there are in excess of forty different types of mixed methods approaches (204). Raushcer & Greenfield (183) state the question for

applied health researchers is not if mixed methods are acceptable, but how they should be combined, support each other and subsequently integrated. They suggest three considerations. First, the researcher must consider the priority given to each type of data collection. As reflected by the research aims and questions, priority is given to quantitative research within this thesis. Next, the author must consider the sequence of the implementation of the methods for data collection. Creswell et al (174, 203) explore a range of models, but the most suitable for this thesis is the sequential explanatory model. Within the sequential explanatory design the researcher first collects and analyses the quantitative data since this is the priority according to the research aims. Second, the researcher then collects qualitative data in order to attempt to provide further explanation of the quantitative research (174, 203). For example, within this thesis if a surprising association is found between one of the aspects of psychological concerns related to falls (e.g. there is no difference in FOF but older adults with CMP have an increased concern about the COF) then this can be explored in a convenience sample to see if an explanation can be found. Lastly, the researcher must consider at what point the data will be integrated. Within this thesis, the synthesis of the quantitative data and qualitative output will largely occur in the general discussion chapter. However, some of this will occur in the qualitative results chapter (chapter 12). Finally, adopting a mixed method sequential explanatory design fits in with the overarching aim of the thesis to publish research findings without delay in a prospective manner in lines with good principles of research (69).

Summary of the methodology chapter

In summary, the rationale for the mixed methods sequential explanatory approach is:

- It is unclear if CMP is associated with changes in physical activity, psychological concerns related to falls and actual falls in community dwelling older adults and this requires the testing of hypothesis that were established from the knowledge acquired from reviewing the literature.
- Priority therefore is given to quantitative investigation to enable statistical inferences to be made.
- However, qualitative interviews will also provide valuable exploration to understand the quantitative results in greater detail and place context upon these findings.
- A mixed methods sequential explanatory model will best address the research aims.
- The researcher's worldview is akin to pragmatism and in particular post-positivism.

CHAPTER 6
GENERIC RESEARCH METHODS OUTLINE

Overview of the chapter

The current chapter provides specific detail regarding the research methods chosen to undertake the primary data collection of the thesis. The chapter describes the participant, public involvement and details on how participants were recruited, instrumentation and analysis of the results. Since the PhD thesis is following a mixed methods sequential explanatory model, the first part considers the primary quantitative research, which forms the major focus of the research in recognition of the research aims and questions. In the second part of the chapter, the research methods and procedures for the secondary qualitative phase of the PhD are considered. More specific details of the methods and data analysis are incorporated within each of the results chapters that individually address the primary or secondary research aims.

6.1 PhD Design

The overarching design of the PhD is a mixed methods sequential explanatory approach, consisting of a major phase of quantitative research followed by a secondary qualitative phase. As detailed in the previous chapter, the greatest emphasis was given to the quantitative research component which is reflected by the research aims. The current chapter provides a consideration of the generic details of the methods used for the PhD. Specific details regarding instrumentation and specific analyses for each research question are contained within the respective results chapters.

6.2 Participant and public involvement (PPI)

Following a preliminary literature review and identification of the possible future directions and research aims, the appropriate methods to answer these were broadly developed. The National Institute for Health Research (NIHR) recommend that an active partnership is made between the researcher, patient, professionals and the public from the outset of a research project (205). In recognition of the NIHR recommendations (205), an effort was made to engage with potential participants and professionals within the first few months of the PhD. First, the researcher attended a meeting with members of a local service user group for older adults with chronic pain and an interest in healthy ageing. At this meeting, the researcher discussed the tentative aims and proposed methods of the research. In an attempt to minimise potential participant burden, members of the panel were asked to consider copies of all proposed questionnaires and other measures at the quantitative phase of the project. The service user group were overwhelmingly supportive the aims of each of the planned primary studies and overall aims were given full support.

As a second step, the researcher liaised and met on several occasions with the local community fall prevention service to discuss the research aims and methods. All members of

the multidisciplinary fall prevention team were invited to a presentation on the research proposal and feedback on the value, aims, design and application of the project was obtained. All feedback was overwhelmingly positive and no significant changes were required. Upon feedback from the service user and professional groups, the research methods were developed in more detail with reference to existing research investigating falls and mobility outcomes in community dwelling older adults with CMP (11, 25).

6.3 Quantitative research methods

The following section will describe general detail of the research methods used for the quantitative phase of the thesis.

6.4 Study design

The quantitative primary data phase of the PhD utilised a multisite cross sectional design recruiting participants in London, the UK. Research conducted across multiple sites offers the advantage of enhancing external validity, improving statistical power and enhances recruitment rates (206). The quantitative studies adhere to the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines (207).

Procedure, Setting and Participants

Identification of Potential Participating Centres

Upon finalisation of the research methods, the researcher sought out local potential community facilities where community dwelling older adults reside (e.g. sheltered housing schemes) or regularly meet (e.g. local community clubs, day centres, church groups). The use of local community facilities such as this offers the potential for large numbers of participants to be recruited from one location and has been employed in previous research investigating psychological concerns in older adults (40). A decision was taken purposefully

to recruit from different community facilities in order to diversify the types of participants that entered the study, since there may be different levels of functioning between those living in a sheltered housing facility and attending a day centre (49). This would therefore potentially increase the generalisability of any research findings beyond any particular setting (e.g. sheltered housing schemes alone).

A list of potentially suitable facilities was developed including sheltered housing schemes, activity clubs for older adults and day centres. The researcher then made contact with a manager at each centre, which often utilised an introductory email/ telephone conversation and a subsequent meeting with the manager at the centre to discuss the purpose of the research and what would be required of potential participants. At this point, the researcher explained in greater detail the aims and protocol of the research and answered any questions. The manager at each centre was given time to consider taking part in the research.

Once a manager at each centre responded indicating that they were interested in taking part, written confirmation was requested for research purposes. Upon receipt of this, the researcher met with the manager at each participating centre and discussed the eligibility criteria in more detail. The manager provided advice on eligible participants that might be interested in participating. In this way, the manager at each participating centre acted as a 'gate keeper', thus reducing the likelihood of inappropriate participants being approached to participate where practically possible. Since the manager at each centre had an overview and knowledge of each person's health and wellbeing, only people that they identified as being suitable and potentially interested were approached. The researcher then attended the centre at an agreed time with a set list of people who were eligible and potentially interested.

Overall, 18 different centres across London and the surrounding areas were approached to take part in the current research. After this process was complete, data were collected from

10 sites including 5 day centres, 3 community activity ‘clubs’ for older adults and 2 sheltered housing schemes. Of the 8 centres that were approached and did not take part, 4 felt unable to facilitate the research at the time they were approached, 2 were not interested in taking part and 2 were not contactable after initial enquiries were made by the researcher. Data collection for the cross sectional quantitative phase across all participating centres was undertaken over an 8 month period (from May 2013 until December 2013).

6.5 Eligibility criteria:

The eligibility criteria were based on recent research investigating mobility outcomes among older adults with CMP (11, 25) and adhered to the PROFANE European falls network falls taxonomy (56). In order to take part in the PhD study, the following inclusion criteria had to be satisfied:

- A) Community dwelling older adults (60 years old and above)
- B) Able to provide informed consent
- C) Mobile over 10 meters with or without a walking aid
- D) Able to understand English.

Exclusion criteria were:

1. A confirmed or suspected diagnosis of mild cognitive impairment and/ or dementia (including those with memory complaints). All day centre/ scheme managers who knew all potential participants provided advice on this.
2. Participants with a recent stroke (within the past year) or any major neurological disorder that could act as a potential cofounder for the research outcomes (e.g. Parkinson’s disease, Multiple Sclerosis).
3. Participants who had recently undergone major surgery (in the past 6 months).

4. Participants with a terminal illness.
5. Participants with a serious mental illness (major depressive disorder, schizophrenia, bipolar disorder).
6. Any person not deemed suitable by the responsible manager for any other reason on the day of data collection.

Pilot study of instrumentation and design

Before the commencement of the main study the procedure for the study including use of instrumentation was tested in a pilot study (n=5) in a sheltered housing scheme not involved with the study. The purpose of this was to examine the feasibility and acceptability of the proposed study (208). No significant changes were required from this process.

6.6 Procedure

The researcher attended each participating centre at an agreed time to undertake the data collection in a quiet location. At some sites, the appointments were pre-arranged with participants, whilst at other centres the primary investigator approached suitable participants to take part on that particular day. On the day of data collection, the researcher approached suitable participants identified by the manager and gave them the participant information sheet (see appendix). Each potential participant was given time to consider the aims of the study and their participation (including those with pre-arranged appointments). At this stage, the researcher gave all potential participants the opportunity to ask questions about any part of the research. Once the potential participant was happy to take part informed consent was sought using the consent form (see appendix).

Before the official commencement of the research and collection of data, the researcher double checked the eligibility criteria with each participant. If any potential participant did

not meet the eligibility criteria they were thanked for their time and interest and excluded before any formal data collection was undertaken. Data were collected over one session by the researcher following a standardised format lasting up to 60 minutes. All questionnaires were administered by the researcher in order to maximise understanding and participation and assist with any questions or comments that may arise. In addition, this may also enhance adherence and the quality of data acquired (173).

6.7 Ethical considerations

In an attempt to ensure that no unsuitable participants were recruited, the researcher sought advice from the responsible manager at each site. The managers knew the potential participants including their medical history and they were able to provide an informed judgement to ensure that only suitable participants were approached. The opinion of the manager on potentially suitable participants was sought on each separate occasion and participants were only approached that were deemed suitable by a responsible person from their respective scheme who knew each individual well. This also reduced the likelihood of recruiting people with mild cognitive impairment (MCI) and/ or dementia or any others for whom the research may have been particularly burdensome. In addition, only participants who were able to provide informed consent were invited to take part and all provided written consent once they had read the participant information sheet. In an attempt to reduce any potential confusion or misunderstanding with the questionnaires, the researcher administered all questionnaires allowing the participant to ask questions as they went along. If any participant was identified as being particularly at high risk of falls, they were as standard advised to make an appointment to see their general practitioner and see a falls specialist.

Ethical Approval

Ethical approval was obtained from the University of Greenwich Research and Ethics Committee in May 2013 (reference number RDC/12/M-3/4.15). Informed written consent was obtained from each individual upon confirmation they satisfied the eligibility criteria.

6.8 Instrumentation

Demographic details and Medical Comorbidities

A demographic questionnaire was developed with reference to the literature considering previously identified factors known to influence falls risk in community dwelling older adults (58, 62), (see Appendix). The demographic questionnaire collected information on participant demographics, living arrangements, details on current medical conditions, including information on self-report physician diagnosed medical conditions (heart conditions (e.g. myocardial infarction, atrial fibrillation, a pacemaker, angina, or congestive heart failure), respiratory conditions (e.g. COPD, emphysema), osteoporosis, rheumatoid arthritis, osteoarthritis, spinal complaints, stroke or Parkinson's disease). Each of the responses to these questions was categorised yes/ no and in accordance with previous research the total number of physician diagnosed medical conditions was noted and confirmed with each participant (11). In addition, participants were asked two questions on dizziness according to a recently published paper (136) "*Since the age of 60 years, have you suffered from the following symptoms: (I) dizziness or vertigo; and (ii) light-headedness when standing up from a seat or bed?*" Participants were classified as experiencing dizziness if they responded yes to either question. Each participant was asked if they had ever had surgery (yes/ no), if they had ever had a joint replacement (yes/ no) or ever had a fracture as a result of a fall (yes/ no). All participants were asked if they currently used a walking aid (indoors or outdoors = yes), wore glasses, had a hearing aid and smoked. All answers were

classified as yes/ no. Participants were also asked to rate their vision on a Likert scale from 1-5 (1=vision is very good, 5 = very poor vision) (209). Participants were asked to provide details of their self-reported height and weight in line with previous research (210) and BMI was calculated. Previous research (210) has demonstrated small differences between self-report and objective based BMI, but indicate this is satisfactory for observational research when BMI is not the primary outcome.

Medications

Participants were asked how many prescribed and over the counter medications they had taken over the past two weeks (11). In accordance with previous research, the total number of medications taken over the past two weeks was calculated (11). Medication is known to have an impact upon the risk of falls (58, 171, 211) and participants were asked if they had taken a number of known medications that have been associated with falls risk including cardiovascular medication, psychotropic medication, benzodiazepines, antidepressants and analgesics. All answers were categorised as yes/ no depending upon the response of the participant.

6.9 Chronic Musculoskeletal pain assessment and classification

All participants were assessed for CMP in accordance with international pain assessment guidelines (13, 212) and in line with previous research in community dwelling older adults (11). CMP was defined as pain which has persisted beyond normal tissue healing time (213) lasting for at least the last month and for 3 of the previous 12 months (11, 21). Information regarding the site, duration and interference upon activities of the pain was established. Details of CMP across 7 bodily locations were ascertained (hands and wrists, shoulders, hip, knee, back, neck and foot pain) and CMP was confirmed when participants reported that pain was present over the past month and for at least 3 of the preceding 12 months (11, 21). Those

who did not have CMP according to these criteria formed the comparison group. Participants were then categorised as 1) no CMP (=comparison group), 2) single site and 3) multisite CMP (pain at \geq two sites;(11)). The duration of CMP was also ascertained.

The Brief Pain Inventory (BPI)

All participants completed the BPI severity (4 items) and interference subscales (7 items; (214, 215)). The BPI is validated for use in older adults (215). The BPI pain severity subscale scores have been used to quantify pain severity in previous research in this field (e.g. (11, 24, 94)). Whilst the BPI assesses general pain rather than a particular site or type of pain, in accordance with previous research participants were asked to consider any pain they had experienced over the previous two weeks (216). Specifically within the BPI pain severity subscale, participants are asked to rate their pain over the two weeks according to four states : (1) worst pain, (2) least pain, (3) average pain and (4) pain now on an 11 point numerical rating scale with 0 indicating no pain and 10 representing “ severe or excruciating pain as bad as you can imagine. ”. Participants reporting no pain were scored as having 0 across the 4 items. The mean score across the four items was calculated and represented the overall score of pain severity (11, 24, 94). Previous research has demonstrated that higher levels of pain are associated with increased disability (22) and falls risk (11). Pain interference with activities was calculated using the 7 item pain interference subscale from the BPI (11, 24, 94). The items ask participants to rate how pain has interfered with 7 activities: (1) general activity, (2) mood, (3) walking ability, (4) normal work, (5) relations with over people, (6) sleep and (7) enjoyment of life. The participant rates how their pain has interfered across each activity on an 11 point numerical rating scale with 0 indicating no interference and 10 meaning completely interfering. A mean score was calculated for the BPI pain interference subscale (11, 24, 94). Participants who reported no pain were scored with 0 across all items. Pain interfering with activities is known to impact upon falls risk (134).

Falls risk assessment

A fall was defined according to the recommendations from the PROFANE European falls network as “*an unexpected event in which the participants come to rest on the ground, floor, or lower level.*” (56). All participants were asked the standard question from the PROFANE falls taxonomy “*During the past year, how often have you had any fall, including a slip or trip in which you lost your balance and landed on the floor, ground, or lower level?*” (56). If a participant stated they had a fall in the previous year, they were asked to recall the exact number of falls. The total number of falls over the past 12 months was recorded and respondents classified as non-, single or recurrent fallers (2 or more falls) (209). The literature review chapter investigating pain and falls (chapter 4) noted that although retrospective recall of falls is the best predictor of future falls, there are concerns about reverse causality when considering the pain and falls relationship. Therefore, in order to negate this risk in the primary data collection, all participants with pain that reported a fall were asked ‘did your pain result from your previous fall?’ (yes/ no). Participants answering yes were excluded from the analysis investigating the relationship between pain and falls.

Health related quality of life

In order to assess HRQOL all participants completed the European Quality of Life Instrument (EuroQoL EQ-5D-5L (217)). The PROFANE network stipulated that this EQ-5D-5L is an acceptable measure to capture HRQOL in falls research studies. Moreover, the EQ-5D-5L is recommended by the Chartered Society of Physiotherapy (218). Within the EQ-5D-5L, participants rated their perceived overall health state from 0 (worst imaginable health state) to 100 (best imaginable health state). Participants are also asked to rate their health on 5 dimensions with questions relating to mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Within each dimension, participants rate their health on a 5 point Likert

scale ranging from 'I have no problems....' (=1) to 'I am unable to...' (=5, most severe problem). The EQ-5D 5L is easy to use and a practical tool to capture HRQOL in older age and takes less than two minutes (218). In addition, the EQ-5D-5L has recently been used in research investigating physical performance and mobility limitations among community dwelling older adults (219).

Assessment of functional mobility

The American and British Geriatrics (2011) international falls guidance document recommends the assessment of gait and lower limb strength and balance for those at risk of falls (61). This is a view echoed by PROFANE (56). In order to assess functional mobility, all participants completed the timed up and go test (TUG; (220)). The TUG test is recommended to screen for falls risk in community dwelling older adults (61) and is a brief test to measure balance and gait. The test measures the time taken (in seconds) for a participant to stand from a chair, walk 3 meters (with any usual walking aid), turn around walk back to the chair and sit down again (220). The test is useful for clinicians as it is quick and provides a composite measure of functional mobility and has been reported to indicate if a person is at increased risk of falls although this may only be the case in lower functioning older adults (221).

Physical Activity

Physical activity was measured using the physical activities scale for the elderly (PASE, (84)). The PASE enquires about the older adults physical activity over the past 7 days accounting for leisure time activity (recreational and sports), household activity (housework, gardening) and work related activity. The PASE received a positive rating in a recent systematic review investigating the psychometric properties of physical activity questionnaires in older adults (105). The PASE is easy and quick to complete (up to 5

minutes) and has been previously used in research investigating physical activity in older adults with CMP (11, 24, 94). The literature review chapter demonstrated that 7 previous studies had investigated physical activity in older adults with CMP, but none had investigated sedentary behaviour. Thus, data on the PASE is not presented in the result chapters as this would not be novel and add to the body of literature. Instead the focus of the result chapter addressing primary aim 1 is on sedentary behaviour.

Sedentary Behaviour

The literature review in chapter 2 established there is a paucity of research considering sedentary behaviour in older adults with CMP. Sedentary behaviour is now established as an important determinant of healthy aging, independent of physical activity with higher levels of sedentary behaviour are associated with adverse health outcomes (31, 35, 222). Sedentary behaviour refers to both posture (sitting or reclining) and low energy expenditure (typically ≤ 1.5 METS) (34). In order to assess sedentary behaviour, the international physical activity questionnaire short form (IPAQ SF, (223)) was used. The IPAQ-SF consists of questions which ask the participating older adult how much time (in minutes or hours) they have spent on average sitting down in the past 7 days on (a) a weekday and (b) a weekend day. All responses were calculated into minutes spent on average being sedentary per day in accordance with previous research (224). The reliance of self-report recall of sedentary behaviour in community dwelling older adults provides a quick and reliable measure which is established as valid and reliable (222).

Psychological concerns related to falls

The systematic review in chapter 3 established there is a paucity of research investigating the psychological concerns related to falling in older adults with CMP (225). The most common psychological concerns are falls efficacy, balance confidence, FOF and concerns about the

consequences of falling. Previous reviews (41, 111) in the wider older adult literature have established there has been inconsistency in the reporting of each of these, with many researchers using the wrong instrument to measure the particular construct they wish to measure. Recent research established that these constructs are related but clearly different constructs (44). An appropriate measurement tool was selected based upon the systematic review chapter findings (225) to measure each of these constructs of psychological concerns related to falls.

Falls efficacy- Short Falls Efficacy Scale International

In order to measure falls efficacy, each participant completed the short falls efficacy scale international (short FES-I) a validated 7 item tool to assess falls efficacy in community dwelling older adults (133). The Short FES-I is also validated in community dwelling adults with cognitive impairment (226). Each item is rated on a four point Likert scale pertaining to the individuals self-efficacy to avoid a fall on a range of activities with answers ranging from not at all concerned (=1) to very concerned (=4). The answers are added together and scores range from 7 (not very concerned about falling over) to 28 (high concerns about falling over). The short FES-has good psychometric and discriminative validity (133).

Balance Confidence – Activities Balance Confidence Scale

In order to assess balance confidence, all participants completed the ABC (114). The ABC consists of 16 questions that enquire about an individual's confidence in undertaking 16 ADL with answers ranging from 0% (= no confidence) to 100% (complete confidence) (114). Each question begins with "*How confident are you that you will not lose your balance or become unsteady when you...?*" The mean score is calculated across the 16 items, with higher scores indicating greater confidence and elucidates whether an individual believes they are able to perform ADL without losing balance and becoming unsteady. A range of

different functional activities are covered ranging from low level activities such as ‘walking around the house’ to much more challenging activities such as ‘walking on an icy pavement’ and ‘walking on an escalator without holding onto the handrail’. The ABC is a valid and reliable measure to assess balance confidence in community dwelling older adults (41, 44).

Fear of falling and avoidance of activities due to FOF

In order to capture the avoidance of activities due to FOF, all participants completed the modified version of the survey of activities and FOF in elderly scale (MSAFFE;(49)). The MSAFFE was developed from the original SAFFE scale (227) and measures FOF and avoidance of activities due to FOF. Participants are asked to identify whether they would avoid 17 activities in case they would fall over on a 3 point scale (1=would never avoid, 2=sometimes avoid, 3=always avoid). Scores are totalled up and range from 17 (low avoidance due to FOF) to 51 (high avoidance due to FOF; (49)). The MSAFFE psychometric properties have been established in community dwelling older adults (49).

Concerns about the consequences of falling

The systematic review in chapter 3 established that no author has investigated the fourth common psychological concern related to falls, concerns about the consequences of falling. Therefore, the COF (49) scale was employed which is a 12 item scale that measures concerns about the consequences of falling among community dwelling older adults. The COF measures 4 types of fear including fear of physical injury, fear of long term physical incapacity, subjective anxiety and social discomfort (49). Each item is rated on a four point scale (1=strongly disagree – 4=strongly agree) with higher scores representing more concerns about the consequences of falling.

Data protection and storage

All participants were assured that their anonymity and confidentiality would be upheld at all times and that participation was optional and would not in any way affect their treatment at the centre. Participant names were coded in a separate file so that only the researcher was able to identify the participant. All information collected was stored in a secure office and behind a password protected computer. Principles of good clinical practice were adhered to at all times.

Data analysis

Details regarding the specific data analyses for each of the primary research chapters are contained within each of the results chapters. This also includes the a-priori power calculations conducted for each specific study, ensuring that each study was adequately powered. All data analysis was conducted with SPSS (version 20, inc Chicago, USA) and StatsDirect software (Version 11, Cheshire, UK).

6.10 Explanatory Qualitative Phase

Upon completion of the quantitative data collection, in accordance with the mixed sequential explanatory methods model chosen, all data were analysed and the research questions were answered. Once the new findings had been established, the researcher sought to publish these in the public domain and conduct the secondary explanatory qualitative phase.

Recruitment and participation in qualitative phase

Following on from the primary quantitative phase, two participating centres were approached to take part in the qualitative phase of the research project. Both of these centres previously expressed an interest in taking part in the qualitative phase. Only individuals that had complete data for the quantitative phase with CMP were considered eligible for the qualitative phase, thus the eligibility criteria remained intact. The researcher contacted the manager at each centre to confirm they were interested in participating in the qualitative phase and a meeting was subsequently arranged to establish a list of eligible participants who took part in the qualitative phase ensuring they still satisfied the inclusion criteria. An agreed time was arranged for the qualitative interviews and suitable participants were approached to take part in the qualitative phase by the researcher. Once again, participants were given a participant information sheet and time to consider participation in the second phase of the study. The researcher was available for questions that arose in relation to the findings from the previous quantitative phase and any relating to the second qualitative phase.

A convenience sample of older adults with CMP was chosen. Specifically, 8 individual semi-structured interviews were conducted in a day centre for older adults whilst a focus group consisting of 12 older adults was undertaken in a sheltered housing scheme. Group discussions in focus groups enables the exploration of topics that may be difficult in an individual setting, whilst other individual's may be able to explore topics in an individual

interview they could not in a group (186). Thus, both formats have advantages and a decision was made to employ both approaches and combine the two, a concept relatively common in pragmatic healthcare research (186). The focus group took place in a sheltered housing scheme for community dwelling older adults whilst the individual interviews were conducted in a day centre for older adults, where they attended on set days for activities. Informed written consent was obtained from all participants and the research was approved by the University Research and Ethics Committee.

The researcher adopted a phenomenological approach because it focuses on the lived experiences of participants of particular phenomenon (228, 229). Specifically, the qualitative phase set out to explore older adults with CMP experiences of physical activity/ sedentary behaviour, falls and psychological concerns related to falling. Within a phenomenological approach, the researcher remains impartial and ‘brackets’ their own experiences and beliefs to better understand and focus on the participants experiences of the phenomenon believing they are best placed to express it (228).

Data Collection for the qualitative research

The interview schedule focused on the participants experiences of 3 key areas relating to mobility difficulties namely 1) physical activity/ sedentary behaviour, 2) psychological concerns related to falls and 3) falls. The interview schedule’s three areas were developed with reference to the literature review chapters and primary quantitative results chapters (137, 225, 230). Semi structured interviews were specifically sought since they consist of open ended questions on particular topics and are ideal to illicit detail accounts of individuals experiences of a particular phenomenon (228, 231). Another major advantage of the semi-structured format is the adaptability; specifically the interviewer can modify the interview format to probe any key ideas that come up to ensure thorough investigation (186, 232).

The interviews were conducted by the researcher in a quiet location at the participating centre. All interviews were digitally recorded and transcribed verbatim. The individual interviews lasted approximately between 15 and 25 minutes (mean 20) and the focus group lasted 86 minutes. The same interview schedule was utilised in both the individual interviews and the focus group. Qualitative interviews were undertaken until the point of saturation (186). At the end of the focus group, participants were asked 7 closed questions (yes/no), four of which started 'Do you think your pain makes you...': a) sit down more? b) More fearful of falling? c) more likely to fall over? d) Enjoy life less? The final 3 closed questions asked if participants believed their pain was a natural part of the ageing process (yes/ no) and if they believed medication and physical activity helped their pain (both yes/ no).

Data analysis for the qualitative research

Following transcription of the interviews, an inductive thematic analysis was undertaken following the method described by Pope and Mays (186). All qualitative analysis was conducted manually without any computer software. Within this, the researcher first read and re-read the transcripts multiple times and developed codes of possible themes to condense the data (186, 233). The transcripts were revisited and potential themes were scrutinised by the researcher until a final set of themes and sub themes were collated (186, 233). The researcher examined all of the interview data to ensure that all manifestations of each theme had been accounted for and considered (186). Throughout this process the researcher made reference to field notes made during the interviews. At this stage, the researcher met with a second researcher to critically discuss the themes with reference to the original verbatim transcripts. Appropriate adaptations were made and another meeting was arranged to discuss the thematic structure with the principal investigator and two other

researchers. At this meeting, amendments were made and final agreement on the thematic analysis was agreed upon with reference to the verbatim and field notes.

Rigour and trustworthiness

Measures were employed to increase trustworthiness. First, field notes were undertaken by the principal investigator during the interviews to ensure that the quotes were taken in its original context (186, 228). In addition, at the point of the thematic analysis, the researcher consulted the notes allowing reflexive analysis of any bias from the principal investigator (228). Lastly, the researcher met with the two other researchers to carefully consider the themes developed from the interviews (186).

6.11 Summary of chapter

The current chapter provides a detailed consideration of the research methods employed within this mixed method sequential explanatory research project. The chapter details the methods utilised in a broad manner with reference to previous literature and the findings from the literature chapters and provides the design for the primary quantitative and secondary qualitative phase. Specific details for each of the individual's studies are contained within the results chapters which now follow.

CHAPTER 7
RESULTS FROM RESEARCH STUDIES

7.1 Introduction to the results chapters

The following results segment of the thesis consists of 5 quantitative studies, each of which includes its own rationale, research methods, results and discussion. Following this, the final and 6th results chapter is presented, which contains the qualitative explanatory component of the thesis. Each of the 6 results chapters answers one of the primary or secondary research aims and contains its own research questions and hypotheses (full list on page 139-140). The driving emphasis of presenting the results chapters as unique studies was to prepare the researcher for academic independence and each chapter was written to resemble a structure required for a unique peer review paper which is in contrast to the traditional long isolated results chapter in PhD theses. Therefore, each chapter contains its own unique introduction to set the scene and own justification and rationale for the study. This is followed by a research methods section related to the data collection, instrumentation and analysis employed within each chapter to answer the relevant research questions(s). Moreover, each chapter contains its own unique set of results finally followed by a discussion of these results with reference to the research question and placing it in the context of the wider literature. Each discussion section within the results chapters also includes a section of the clinical implications of the results in addition to future research recommendations. Each results chapter is progressive and interlinked, yet is unique in its pursuit to answer the research questions derived from the systematic review chapters.

7.2 THE AVOIDANCE OF ACTIVITIES DUE TO FEAR OF FALLING CONTRIBUTES TO SEDENTARY BEHAVIOUR AMONG COMMUNITY DWELLING OLDER ADULTS WITH CHRONIC MUSCULOSKELETAL PAIN: A MULTI-SITE OBSERVATIONAL STUDY

The current chapter is based on the published paper:

Stubbs B, Patchay S, Soundy A, Schofield P. (2014). The avoidance of activities due to fear of falling contributes to sedentary behavior among community-dwelling older adults with chronic musculoskeletal pain: a multisite observational study. *Pain Med.* 2014 Nov;15(11):1861-71.

This chapter addresses primary aim 1.

Overview of the chapter

The current chapter presents the first primary results paper from the PhD and addressed primary aim 1. The first literature chapter (chapter 2) established that older adults with CMP engage in less physical activity than older adults with CMP. Of particular importance, the systematic review found that no author had at that time investigated sedentary behaviour in a sample with and without CMP. Given the growing importance of preventing sedentary behaviour, the first results chapter focused on the investigation of sedentary behaviour. Within this chapter, the rationale for the current study is justified through an updated consideration of the literature on sedentary behaviour in older adults. The current results chapter found that those older adults with CMP within the study spend significantly more time being sedentary than a group of similar age and sex without CMP equating to about 3.5 hours. Moreover, the current chapter finds the first evidence to suggest that the avoidance of activities due to FOF is a major contributor to the sedentary behaviour in those with CMP. Clinical implications are discussed and directions for future research described.

7.3 Introduction

It is widely established that physical activity has a plethora of beneficial effect upon the health and quality of life of older adults (31, 77, 234). Conversely, low levels of physical activity are related to adverse health and wellbeing and physical inactivity is the fourth leading cause of global mortality, accounting for approximately 3.2 million deaths every year (33). Physical activity refers to ‘*any bodily movement produced by skeletal muscles that results in energy expenditure*’ (26). With an ageing population, it is important that physical activity is promoted as it is associated with positive ageing (31) and has a beneficial effect upon a range of the common and burdensome non-communicable diseases such as cancer, cardiovascular disease, high blood pressure, obesity and diabetes (33, 79, 235, 236). In addition, physical activity prolongs independence (82) and reduces depressive symptoms in community dwelling older adults (29). Recently, interest has grown in reducing sedentary behaviour among older adults, due to emerging evidence that it is associated with adverse health outcomes independent from physical activity participation (80, 236, 237). Sedentary behaviour is distinct from physical activity and is defined as participation in activities such as sitting, lying down and reclining during waking hours that do not increase energy expenditure substantially above an individual’s basal metabolic rate (34, 237).

Chronic musculoskeletal pain is a pervasive issue among community dwelling older adults affecting approximately 50% of those living in the community (13). Both the promotion of physical activity and the prevention of sedentary behaviour are pertinent issues among older adults with CMP. For instance, previous research has demonstrated that physical inactivity is a risk factor for development of CMP (238). Moreover, physical activity is recommended for both the prevention and management of CMP (13, 239). A recent systematic review of 60 randomised controlled trials demonstrated that physical activity has a beneficial impact on pain and disability in older adults with lower limb osteoarthritis (39). Given this, it is

concerning that the first systematic literature review chapter (chapter 2) established that older adults with CMP are significantly less active than older adults without CMP. At the time the literature chapter was completed, no author had set out to investigate sedentary behaviour in older adults with CMP. Since then, Ryan et al (240) have investigated this and found that that sedentary behaviour is more common in older adults with CMP than older adults without CMP. Whilst helpful, further research is needed to confirm or refute this and also investigate the potential factors that contribute to sedentary behaviour among older adults with CMP.

For some time, research in the pain literature has suggested that older adults with CMP may engage in less physical activity due to fear avoidance (116). Although the literature review chapter (chapter 2) established that older adults with chronic pain engage in less physical activity, it remains unclear if older adults with CMP are more sedentary than those without pain and what the possible contributing factors are. Assuming that the finding of Ryan et al (240) are replicated and older adults with CMP are more sedentary, a number of possible explanatory factors could potentially contribute to this. A recent qualitative study by Chastin et al (232) reported that pain is an important determining factor in sedentary behaviour and often causes a lack of energy and social isolation. Whilst this provides a useful insight, quantitative research is required to establish if these results are generalizable. However, pain and particularly pain that interferes with ADL may contribute to sedentary behaviour since it is associated with increasing mobility limitations (25). The second literature chapter (chapter 3) also provided some reasons to suggest that pain may increase psychological concerns related to falls and in particular increase avoidance of activities due to FOF and postulated that increased concerns about the consequences of falling may also be a pertinent factor. The potential avoidance of activities and concerns due to FOF in older adults with CMP seems a relevant factor as the third literature review chapter (chapter 4) established that older adults with CMP are at increased risk of falls. Thus, in addition to the factors identified within the

general population such as increasing age, more commodities, depressive symptoms and higher BMI (80, 241), it seems plausible that the increased risk of falling, avoidance of activities due to a FOF and pain interference could increase sedentary behaviour among older adults with CMP. With an ageing global population and a substantial proportion of older adults affected by CMP, the potential impact of sedentary behaviour among this population is profound.

In recognition of the findings of the literature review chapter (chapter 2) and the aforementioned justification, the first results chapter sought to answer the following two research questions:

- 1) Are older adults with CMP more sedentary than people without CMP of similar age and sex without CMP?
- 2) What factors contribute to the sedentary behaviour among older adults with CMP?

It was hypothesised that pain interference, the avoidance of activity due to FOF and increased concerns about the consequences of falling would significantly contribute to sedentary behaviour among older adults with CMP over and above risk factors previously identified. More specifically, it was hypothesised that each of these factors would be a significant independent predictor of the variance of sedentary behaviour in a sample of older adults with CMP.

7.4 Method

The current results chapter utilises data acquired from the cross sectional quantitative phase of the thesis. The research methods used including design, setting, location and selection of participants conforms to those described in the generic methods chapter (chapter 6) and followed the STROBE guidelines (207). The research methods described here contain more specific detail regarding the variables, instrumentation and analysis required to answer the a-priori research questions.

Demographic and medical information

For the purposes of the current results chapter, details of participants demographic information was ascertained including age (years), gender (male/female) and current living arrangements (based on a single question considering whether individuals live alone and answered either as yes or no). The total number of self-reported physician diagnosed comorbidities and number of medications taken over the past two weeks was calculated in accordance with previous research (24, 94). Moreover, specific enquiries were made about certain medications including analgesics and all answers were recorded as yes or no. The use of walking aids by each participant was classified as either yes or no. In addition, details regarding vision and BMI were utilised for the current results chapter. More details about the ascertainment of these are presented in chapter 6 the research methods chapter.

Quality of life and Depressive symptoms

Each participants overall health state (HRQOL) was utilised from the EQ-5D-5L instrument (217). In recognition that depression may affect both pain (17) and sedentary behaviour (242) all participants rated their depressive symptoms on a Likert scale from 1 (I am not anxious or depressed) to 5 (I am severely anxious or depressed;(217)).

Chronic musculoskeletal pain assessment and classification

Chronic musculoskeletal pain was assessed in accordance with international pain assessment guidelines (13, 212) and in line with previous research in community dwelling older adults (11) as outlined in chapter 6 the methods chapter. Specifically for the current results chapter the information regarding the site of the CMP (hands and wrists, shoulders, hip, knee, back, neck and foot pain) was established. Those who did not meet this criteria for CMP formed the comparison group.

Brief Pain Inventory

The mean BPI interference subscale scores were calculated in accordance with previous research to provide an overall score of pain interference (11, 216). The BPI measures general pain rather than site specific and is validated for use in older adults (215).

History of falls

Each participant was asked '*In the past 12 months, have you had any falls including a slip or trip in which you lost your balance and landed on the floor or ground or lower level?*' (56). Participants responding yes were classified as fallers. A fall was defined as '*an unexpected event in which the participants come to rest on the ground, floor, or lower level*' (56).

Functional mobility assessment

All participants completed the timed up and go test (220) which is commonly used to assess lower limb function and mobility in community dwelling older adults. The test requires the participant to stand up from a chair, walk 3 meters, turn around, walk back and sit down again and the time taken is measured in seconds. Higher TUG scores indicate more substantial mobility limitations in older adults with CMP (25).

Sedentary behaviour

All participants completed the questions regarding sedentary behaviour from the IPAQ SF (223). The questions enquire about the amount of time spent sitting per day over the previous week (hours and minutes per day). Participants were provided with examples of sitting behaviour such as sitting at home (e.g., watching television, reading), at work (sitting at a desk) and during leisure time (e.g., visiting a friend) to aid their answer. In accordance with previous research (224) if participants were unable to answer due to variations in the pattern of sitting from day to day they were asked “what is the total amount of time you spent sitting yesterday?”. Previous research (243) has demonstrated that the IPAQ SF is a valid, reliable and useful tool to assess sedentary behaviour in community older adults.

Fear of falling and avoidance of activities due to fear of falling

The modified version of the survey of activities and FOF in elderly scale (MSAFFE; (49)) was used with all participants to determine avoidance of activities due to FOF. The MSAFFE is a valid and reliable measure for community dwelling older adults (41, 49, 225). More details about the MSAFFE are given in the research methods chapter. The MSAFFE was chosen since it measures the avoidance of activities due to FOF and the literature review chapters proposed that this may contribute to heightened sedentary behaviour.

Concerns about the consequences of falling scale

All participants completed the COF (49). The COF scale consists of 12 items that measure concerns about the consequences of falling among community dwelling older adults. The COF measures 4 types of fear including fear of physical injury, fear of long term physical incapacity, subjective anxiety and social discomfort (44, 49). Each item is rated on a four point scale (1=strongly disagree to 4=strongly agree) and higher scores represent more

concerns about the consequences of falling. The COF is different from the MSAFFE because it measures fear regarding the consequences of falling, whilst the MSAFFE measures behavioural avoidance due to FOF (41, 44). Since the COF measures excessive concerns about the consequences of falling over, it was chosen to see if heightened concerns may account for excessive sedentary behaviour.

Statistical analysis

The data collected for the current results chapter was analysed using SPSS. Firstly, tests of normality were conducted on the data including a visual inspection of probability plots (PP) plots and skew and kurtosis were calculated for continuous data. The data were assessed for outliers and 10 cases were subsequently removed due to incomplete/ missing data (244). Non-normally distributed data (TUG scores) was log transformed and Levene's test for homogeneity of variances was assessed (244). When these assumptions were satisfied, independent t-tests and Chi squared tests were used to analyse differences in continuous and categorical data respectively between those with CMP and the comparison group (research question 1). When these assumptions were not met, non-parametric equivalents were used. An exploratory subgroup analysis of variance (ANOVA) with a post hoc Tukey test was conducted to investigate if IPAQ-SF scores differed between the comparison group and the 7 different sites of CMP (hands and wrists, shoulders, hip, knee, back, neck and foot pain). In order to investigate the predictors of sedentary behaviour, a hierarchical multiple regression analysis was performed with the IPAQ-SF scores as the dependent variable. Within the first step, demographic (age, living arrangement, BMI), medical (number of comorbidities, number of medications, analgesic medication (yes/ no), osteoarthritis (yes/ no), osteoporosis (yes/ no), dizziness, depression rating, vision rating), quality of life (EQ-5D-5L scores) and mobility measures (walking aid use, TUG scores, history of falls) were inserted into the model. In the second step, pain interference (BPI interference scores) and avoidance of

activities due to FOF (MSAFFE) were inserted into the model and to investigate the influence of these on sedentary behaviour by noting the R^2 change in the model. In the final step, the concerns about the COF were inserted into the hierarchical regression model to investigate the R^2 change in IPAQ scores. The standardised beta-coefficients for each independent variable are reported to establish their contribution within the hierarchical regression model. In order to assess for multicollinearity, the variation inflation factor (VIF) and tolerance for each model were calculated ensuring these were within satisfactory ranges (VIF <10 and not much higher than 1; and tolerance > 0.2; (244)).

Sample size calculation

An a priori sample size calculation was conducted with G power software. Using an alpha of 0.05 with a power of 0.80, and a medium effect size of 0.5 based upon previous research (21), a power calculation determined that 64 participants were required to detect a true significant difference between the two groups.

7.5 Results

A total of 401 community dwelling older adults were invited to take part in the cross sectional quantitative phase of the study. Of these, 285 participants had valid data for the current study (71.1%). Among those that were eligible but did not take part, 75 (18.7%) were not interested in participating in the research and declined the offer to participate. In addition, 31 (7.7%) participants met one or more of the exclusion criteria and 10 participant's data were incomplete and could not be used in the data analysis.

Of the included sample, 144 individuals met the criteria for CMP (50.5%) and 141 individuals did not have CMP and formed the comparison group. Although none of the comparison group had CMP, a small proportion (14.8%, 21/141) reported some mild pain over the previous four weeks. There were no significant differences in the age of older adults with CMP (78.4 years) compared to the comparison group (76.6 years, $p>0.05$), nor in the proportion of females in each group. However, compared to the comparison group, those with CMP were more likely to live alone (71.5% vs. 58.5%, $p=.02$), more likely to wear glasses (68.1% vs. 54.6%, $p=.02$) and use a walking aid (63.8% vs. 26.2%, $p<.001$). In addition, those with CMP had more comorbidities than the comparison group (3.9 vs 2.8, $p<.001$) and they rated their overall HRQOL substantially below the comparison group (58.4 vs. 79.7; $p<.001$). The older adults with CMP reported moderate pain interference with a mean score across the BPI interference subscale of 4.8 (± 1.9). In addition, 70.8% (102/144) of older adults with CMP were taking analgesic medication, 68.1% (98/144) reported 'ok' or better vision and 43.7% (63/144) reported feelings of slight anxiety or depression or greater. A summary of the demographic and medical differences between the two groups are presented in table 7.1.

Table 7.1 – Demographic, medical and health related quality of life measures among those with and without CMP in the study

Variable	Comparison group (n=141)	Chronic musculoskeletal pain group (n=144)	P value
<i>Age (years, SD)</i>	76.71 ±8.51	78.47±7.82	.07
<i>Female's n (%)</i>	95 (67.4%)	95 (65.9%)	.91
<i>Live alone n (%)</i>	83 (58.8%)	103 (71.5%)	.026
<i>Wear glasses n (%)</i>	77 (54.6%)	98 (68.1%)	.02
<i>Cardiac comorbidity n. (%)</i>	23 (16.3%)	59 (40.9%)	<.001
<i>Respiratory comorbidity n (%)</i>	19 (13.5%)	30 (20.8)	.11
<i>Osteoarthritis n (%)</i>	36 (25.5%)	94 (65.2%)	<.001
<i>Osteoporosis</i>	16 (11.3%)	32 (22.2%)	.03
<i>Degenerative disc/ spinal problems n (%)</i>	15 (10.6%)	36 (25%)	.02
<i>Number of comorbidities n. ±SD</i>	2.79±1.39	3.93±1.22	<.001≠
<i>Walking aid use n (%)</i>	37 (26.2%)	92 (63.8%)	<.001
<i>Overall HRQOL (±SD)</i>	79.74±15.68	58.42±20.70	<.001
<i>BPI interference (±SD)</i>		4.8±1.9	

Key table 7.1: SD= standard deviation, n=number, HRQOL- health related quality of life, BPI interference= brief Pain interference subscale, ≠ non parametric test used

Mobility, falls, avoidance of activities due to FOF and sedentary behaviour among participants

Considerably more people in the CMP group (86/144, 59.7%) reported a history of falls compared to the comparison group (47/141, 33.3%, $p<.001$). Older adults with CMP were significantly slower completing the TUG test with a mean time of 14.7 seconds compared to 10.9 seconds in the comparison group indicating more pronounced mobility limitations. The older adults with CMP reported experiencing significantly higher levels of avoidance of activities due to a FOF (28.5 ± 7.8) compared to the comparison group (21.7 ± 6.2 ; $p<.001$) on the MSAFFE. Older adults with CMP also expressed significantly higher levels of concerns

about the consequences of falling compared to the age and sex matched comparison group (32.1 vs. 25.7; $p < .001$).

Older adults with CMP spent on average 11.5 hours a day being sedentary compared to 7.9 hours a day in the comparison group ($p < .001$). This equated to an increase of approximately 3.6 hours a day being sedentary in those with CMP. The exploratory subgroup analysis demonstrated that compared to the comparison group, those with chronic foot pain ($n=17$, 11.8 hours, $p < .001$), knee pain ($n=60$, 11.6 hours, $p < .001$), back pain ($n=32$, 10.3 hours, $p = .009$) and hip pain ($n=13$, 11.3 hours, $p = .016$) were all significantly more sedentary. The summary of the mobility, falls history, psychological concerns related to falling and sedentary behaviour outcomes are presented in table 7.2.

Table 7.2: Falls, psychological concerns related to falling and sedentary behaviour among participants

Variable	Comparison group (N=141)	Chronic musculoskeletal pain group (N=144)	P value
<i>Sedentary behaviour per day (Hours a day, \pmSD)</i>	7.93 \pm 3.78	11.5 \pm 3.0	<.001
<i>History of falls n (%)</i>	47 (33.3%)	86 (59.8%)	<.001
<i>Timed up and Go (secs, \pmSD)</i>	10.96 \pm 4.46	14.77 \pm 6.32	<.001
<i>COF scale (\pmSD)</i>	25.7 \pm 5.9	32.1 \pm 5.1	<.001
<i>MSAFFE (\pmSD)</i>	21.76 \pm 6.2	28.55 \pm 7.8	<.001

Key = SD= standard deviation, COF = consequences of falling scale, n=number, MSAFFE = survey of activities and fear of falling in elderly scale, \neq non parametric test used

Hierarchical regression analysis of factors contributing to sedentary behaviour

The background demographic, medical and mobility risk factors for sedentary behaviour explained a significant amount of the variance within the sedentary behaviour (IPAQ scores) accounting for approximately 40.4% ($F_{[15,126]}=5.68$, $p<.001$, $R^2 =0.404$, adjusted $R^2=0.333$). Within the first step of the model, the largest unique contribution to the model was made by TUG scores ($\beta=0.287$, $p<.001$) followed by HRQOL scores ($\beta=-0.254$, $p=.002$) which was negatively associated with sedentary behaviour.

The introduction of the BPI interference and MSAFFE scores at the second step contributed to a significant increase in the variance explained within the IPAQ scores from 40.4% to 50.8% equating to a R^2 change of 10.4% ($F_{[2,124]}=13.1$, $p<.001$; adjusted R^2 0.441). Within the fully adjusted model the MSAFFE scores were the largest independent significant predictor of sedentary behaviour ($\beta=0.461$, $p<.001$). Other significant contributors to the variance in sedentary behaviour in the final model were HRQOL ($\beta=-0.226$, $p=.002$), TUG scores ($\beta=0.206$, $p=.012$) and BMI ($\beta=0.157$, $p=.038$). The standardised beta-coefficients for the final model and unique contribution of each of the independent variables are presented in table 7.3.

Table 7.3 Summary of hierarchical regression analysis for variables predicting sitting time in older adults with chronic musculoskeletal pain

Variable	Step 1			Step 2		
	B	SE B	β	B	SE B	β
Constant	540.180	190.501		516.463	174.913	
Age years	1.288	1.866	.055	.453	1.722	.019
Gender	12.392	28.596	.032	-14.845	26.775	-.039
Number of comorbidity	20.944	14.317	.142	6.972	13.401	.047
Number medications	6.378	7.992	.071	10.097	7.354	.113
History of falls	29.450	27.474	.080	17.306	26.115	.047
Walking Aid	55.263	32.213	.147	17.495	30.944	.047
Dizziness	-16.245	12.742	-.092	-11.715	11.764	-.066
HRQOL	-2.222	.685	-.254**	-1.972	.633	-.226**
Timed get up and go	8.217	2.485	.287***	5.903	2.320	.206*
Pain Medication	-24.214	29.690	-.061	-11.553	27.708	-.029
Anxiety and Depression	28.808	15.514	.141	-3.440	15.586	-.017
BMI	-4.427	3.384	.104	-6.722	3.204	.157*
Vision rating	4.455	16.241	.020	14.290	14.994	.066
Osteoarthritis	-50.607	30.824	-.133	-55.546	28.250	-.146
Osteoporosis	-25.766	33.213	-.060	-28.824	30.436	-.067
BPI pain interference				-3.699	7.627	.038
MSAFFE				10.613	2.083	.461***

Key for table 7.3: *= p<.05, **= p<.01, *** = p<.001, B and SE (standard error) B= unstandardized coefficients, β = standardised beta coefficients. , HRQOL = health related quality of life, BPI=brief pain inventory, MSAFFE= modified version of the survey of activities and fear of falling in elderly scale.

Finally, when the COF scores were inserted into the model this did not make any detectable or significant change in the variance in the IPAQ scores (R^2 change=0.01, F[1,123]=0.148, p=0.701) and actually decreased the adjusted R^2 slightly from 0.441 to 0.437.

7.6 Discussion

Within the first primary results chapter, it was established that older adults with CMP spend approximately 3 and a half hours a day more being sedentary than the comparison group without CMP of similar age and sex. The hierarchical regression analyses demonstrated that the introduction of pain interference and avoidance of activities due to FOF (MSAFFE scores) significantly increased the variance in the time older adults spend sitting each day with an R^2 change of 10.4%. Within the fully adjusted model, MSAFFE scores were the largest significant predictor in sedentary behaviour in older adults with CMP. Surprisingly however, pain interference was not an independent predictor of sedentary behaviour in the CMP group. Moreover, the addition of the COF scores (concerns about the consequences of falling scale) did not increase the variance observed within the amount of time older adults with CMP were sedentary. Therefore, the current results provide provisional evidence that the avoidance of activities due to FOF is an important and significant contributor to sedentary behaviour among older adults with CMP. In fact, in this group the avoidance of activities due to FOF appears to be a more significant contributor to sedentary living than excessive concerns about the consequences of falling and pain interference. Thus, the current results chapter has demonstrated how psychological concerns related to falls, namely the avoidance of activities due to FOF appear to influence sedentary behaviour over and above previously established risk factors.

Relevance of sedentary behaviour among older adults with chronic musculoskeletal pain

The amount of time that both those with and without CMP in the current study spent being sedentary is high. However, a recent meta-analysis (241) established that 65% of older adults in the general population spend in excess of 8.5 hours of their waking day being sedentary and the comparison group in the current chapter spent almost 8 hours per day being

sedentary. Older adults with CMP were sedentary on average over 11 hours sitting during their waking hours. The current finding that older adults with CMP are substantially more sedentary than those without CMP is potentially of interest to clinicians, researchers and policy makers for several reasons. First, sedentary behaviour is associated with an increased risk of cardiovascular disease, obesity and premature mortality (33, 241). Secondly, physical inactivity is related to the progression of disability (245) in people with CMP. In addition, promoting physical activity is central to the management of CMP (13) and reduces both pain and disability (39). As previously stated, to the best of the researchers knowledge, only one study has previously investigated sedentary behaviour in a sample of older adults with CMP (240). The authors of this previous study found that sedentary behaviour was high among older adults with CMP and was an independent predictor of cardiovascular disease in older adults but not middle aged adults. Since, sedentary behaviour is a potential modifiable lifestyle factor that may reduce the risk of cardiovascular disease, preventing sedentary behaviour should be a high priority.

Given the findings of the current chapter, clinicians should seek to encourage those with CMP to disrupt prolonged periods of sedentary behaviour and engage in physical activity which can be adapted to the individuals needs ensuring it is safe (246). However, knowledge about sedentary behaviour from qualitative research will help elucidate further understanding of why this occurs and how it can be overcome and this will be addressed in the final results chapter (chapter 12). However, disrupting sedentary behaviour could include any activity that increases their energy expenditure that they enjoy, which is a message recently proposed in the British Medical Journal (BMJ) that some activity is better than none (246). Within the general older adult literature, there is overwhelming robust evidence that structured physical activity (exercise) reduces falls (168), including injurious falls (169) and is as effective in reducing mortality as some medication, including that for cardiovascular disease (247).

However, there have been some reports in the literature that increasing physical activity may lead to falls (248). Stubbs et al (59) recently conducted an umbrella review of meta-analyses of RCTs and found that exercise interventions have been the most consistent significant intervention to reduce falls and appear to have minimal major adverse effects. Given this, if a clinician has concerns about the older person's falls risk, a physiotherapist could oversee this process ensuring the safe implementation of physical activity. The education of older adults with CMP to disrupt sedentary behaviour should also play a role. The need for this is exemplified in a recent qualitative study which established that older adults engaged in sedentary behaviour to manage CMP (232). However, in this study the participants did not see excessive sitting as being detrimental to their wider health and only acknowledged it may be harmful for them due to a worsening of pain and stiffness. Thus, clearly further qualitative research is required to better understand these relationships.

Possible reasons for the excessive sedentary behaviour among older adults with chronic musculoskeletal pain

The results from the current chapter provide some provisional explanation of the possible reasons why older adults with CMP are more sedentary. Much in accordance with the chronic pain literature, the sample had a higher incidence of past falls, poor mobility and reported more depressive symptoms. In conducting the hierarchical regression analysis when all other factors were controlled for (including age, comorbidities, BMI, depressive symptoms, medications, falls history), the avoidance of activities due to FOF remained the largest single predictor of sedentary behaviour. However, increased avoidance of activities due to a FOF may in part be warranted since numerous authors have established that pain is associated with an increased risk of falls (11, 134, 162, 163, 230, 249) and others have found that older adults with CMP have increased mobility limitations (24, 25). Within the general older adults FOF literature, previous research has demonstrated that for many older adults

FOF is commensurate with their physiological risk of falls (42). Interestingly, although numerous authors have found that pain intensity increases the risk of falls (11, 162) this relationship was not evident in the current sample. Reasons for this finding are unclear, but it may suggest that the other factors (particularly avoidance due to FOF and mobility limitations) may have a more important contribution to sedentary behaviour, although pain interference possibly contributes to these factors themselves and therefore warrants investigation. The reasons for this could possibly be because the duration of pain (i.e. presence of CMP) is a more pertinent factor than pain interference in relation to sedentary behaviour. Therefore, clearly the relationship between CMP, mobility factors, avoidance of activities due to FOF and sedentary behaviour is complex, multifaceted and some of these relationships may be bidirectional. Once again, the value of qualitative research will help disentangle and better understand these relationships.

Although the regression model in the current study explained 50.8% of the variance in sedentary behaviour, there are almost certainly other factors that could contribute such as gait disturbances, medication and muscle strength. In order to clearly elucidate the influence of the contributing factors to sedentary behaviour, prospective longitudinal research is required to disentangle these complex relationships and answer the questions that it was not possible to do in the current study. Future research should include a particular focus on physiological falls risk factors. In line with the literature, the current chapter found that avoidance due to FOF was a more important predictor than concerns about the consequences of falling over (43). In the wider pain literature, Sions and Hicks (116) recently established that older adults with CLBP that experienced fear avoidant beliefs, significantly increased their falls risk. However, to the best of the researcher's knowledge, the current study is the first to establish that fear avoidance due to FOF contributes to the increased amount of sedentary behaviour in older adults with CMP.

Limitations of the results of the chapter

General limitations are presented in section 11.6, but limitations specific to this chapter include the use of self-report measure of sedentary behaviour. Although self-report measures to capture sedentary behaviour have been used extensively in older adults research (241) there are some concerns about the accuracy approach. The researcher attempted to reduce this concern by using the IPAQ-SF, which psychometric properties have been established in the general older adult population (243). Despite this, the reliability and validity of the IPAQ-SF in older adults with CMP is unestablished.

Clinical implications and future research

The current results provide provisional evidence that avoidance of activities due to FOF appears to be an important contributing factor to the excessive sedentary behaviour in older adults with CMP. With this in mind, clinicians should consider addressing fear avoidance with patients whilst also decreasing their risk of falls and mobility limitations. In order for this to be successful, this should incorporate pain management strategies. Physical activity programs that meet individual preferences should be central to this as it can reduce pain and disability (39) and decrease falls risk (168). Education and increasing self-efficacy is likely to be essential to achieve this particularly if older adults believe that physical activity is harmful to them. Future prospective studies should seek to establish the influence of CMP on sedentary behaviour and the contributing factors with a particular emphasis on the avoidance of activities due to a FOF. This should seek to use an objective measure of sedentary behaviour and falls should be monitored prospectively using falls calendars. Qualitative research with a convenience sample of older adults with CMP may also help disentangle the relationship between pain, falls, avoidance of activities due to FOF and sedentary behaviour. In addition, future research is needed to understand the actual falls risk in older adults with

CMP given the increased avoidance of activities due to FOF. There has been considerable discussion in the literature on differences between perceived (i.e. increased concerns) versus actual physiological increased risk of falls in the literature (42). Therefore, in order understand the impact of physiological falls risk, research is required to understand how CMP and number of pain sites may influence actual falls in this population.

7.7 Summary of the chapter

The results from the current chapter demonstrate that older adults with CMP spend over 11 hours a day being sedentary. This represents approximately 3 and a half hours more than a comparison group of similar age without CMP. The avoidance of activities due to FOF appears to be the major contributing factor to this excessive sedentary behaviour in older adults with CMP. With an ageing population, the high proportion affected by CMP and the fact that physical inactivity is a leading cause of avoidable death, future research is urgently required to disentangle this relationship and reduce sedentary behaviour in older adults with CMP. Given the fact that older adults with CMP are avoiding more activities due to FOF, it is important that future research also investigates if this population are at increased risk of actual falls and this is the key aim for the next results chapter (chapter 8).

CHAPTER 8

THE INFLUENCE OF THE NUMBER OF PAIN SITES ON FALLS AND CONSIDERATION OF THE BRIEF PAIN INVENTORY TO IDENTIFY THOSE AT RISK OF RECURRENT FALLS

This chapter is based on the published paper:

Stubbs B, Eggermont L, Patchay S, Schofield P. (2014). Older adults with chronic musculoskeletal pain are at increased risk of recurrent falls and the brief pain inventory could help identify those most at risk. *Geriatrics and Gerontology International*. 2014 Aug 28.

This chapter relates to primary aim 3.

Overview of the chapter

The current results chapter provides an investigation of the influence of CMP and the number of CMP sites (none, single or multisite) on falls (any, single or recurrent). The literature review chapter identified that no author had set out with the primary aim to investigate the relationship between number of CMP sites and recurrent falls. Moreover, the current study built upon numerous limitations in the pain and falls studies to date where practically possible. Specifically the study also investigated the discriminative ability of the BPI to identify those who experience recurrent falls. The study found that older adults with multisite CMP are at greatest odds of experiencing recurrent falls. The results chapter also provides provisional evidence that the BPI may be able to identify those at risk of recurrent falls.

8.1 Introduction

Falls are often devastating in older age and are associated with reduced function, premature admission to long term care facilities and considerable morbidity and mortality (250, 251). The financial impact of falls is also profound (250-252) and around a third of older adults over the age of 65 fall each year (52, 55, 61). With an ageing global population the international emphasis on preventing falls is increasing (52).

In order to prevent falls, it is important that contributing risk factors are identified and ultimately interventions developed to negate their risk (61). Recently, research has begun to consider if older adults with pain and in particular CMP are at an increased risk of falls (11, 51, 145, 146). The relationship between CMP and falls is of great clinical relevance as CMP is highly prevalent affecting approximately 50% of community dwelling older adults (13, 15). The literature review chapter (chapter 4) contained numerous meta-analyses demonstrating that chronic pain is associated with an increased risk of falls (≥ 1 ; (230)) and in particular recurrent falls (249). However, the literature review chapter identified a number of limitations in the literature to date. For instance, relatively few authors defined a fall and secondly, most studies have not clearly assessed CMP in line with recommended pain assessment guidelines and did not consider the influence of the number of CMP sites, pain severity and/ or interference (13, 212). This questions whether we have an accurate indication of the relationship between CMP and falls. To date, only one study (11) has clearly assessed CMP and investigated the relationship with falls, but the authors did not investigate the association with recurrent falls (11). Recurrent fallers (those who fall two or more times over 12 months, (148)) are at greatest risk of experiencing the plethora of adverse consequences of falling and are therefore a clinical and research priority (61, 140, 142). Given the fact that CMP and falls are common and highly problematic in community

dwelling older adults, it is essential that this association is accurately explored with particular emphasis on recurrent falls.

A key strategy to prevent falls in clinical practice is the use of falls screening tools to discriminate between fallers and non-fallers (253). With mounting evidence that pain is associated with falls including the published findings of the fourth literature review chapter (11, 146, 162), it seems possible that a pain assessment tool could prove useful and discriminate between fallers and non-fallers. To date, no study has investigated the discriminative validity of a widely-used pain assessment tool. Therefore the current results chapter also investigated whether the BPI (214, 215) a simple, validated and commonly used tool in older adults (11, 216), could differentiate between fallers (≥ 1) and non-fallers and secondly, recurrent fallers (≥ 2) and non-fallers.

The research questions for the current chapter were to:

- 1) Establish if older adults with CMP are more likely to experience a) any (≥ 1), b) single and c) recurrent falls than a comparison group without CMP?
- 2) To establish if the odds of a) any (≥ 1), b) single and c) recurrent falls differs between those with single and multisite pain compared to the comparison group?
- 3) Investigate the discriminative validity of the BPI to differentiate between non-fallers and a) any falls (≥ 1) and b) recurrent fallers in older adults with CMP.

It was hypothesised that those with multisite CMP would be most likely to experience single and recurrent falls.

8.2 Method

Study design and Participants

The current results chapter utilised a cross sectional design which was collected over an 8 month period (May to December 2013) across 10 participating centres in England (5 day centres, 2 sheltered housing schemes and three community ‘clubs’ for older adults). Further details on the recruitment procedure and eligibility criteria are clearly detailed in the research methods chapter (chapter 6). Written informed consent was obtained from each participant and the study was approved by the University of Greenwich research and ethics committee. The specific variables of interest which were utilised in the analyses to answer the research questions are briefly explored.

Demographic information, medical history, medication use and Quality of life

For the purposes of the current study demographic details including age (years), sex and living arrangements (live alone yes/ no) were recorded. In accordance with previous research the mean number of self-report physician diagnosed comorbidities and medication consumed over the previous two weeks were recorded. Each participants overall health state (HRQOL) was captured with the EQ-5D-5L (217).

Chronic musculoskeletal pain assessment and classification

Chronic musculoskeletal pain was assessed in line with recognised pain assessment guidelines (13, 212). CMP was confirmed when participants reported that their musculoskeletal pain was present over the past month and for at least 3 months of the previous year (11, 21). Participants were then categorised as 1) no CMP (=comparison group), 2) single site and 3) multisite CMP (pain at \geq two sites;(11)).

Brief Pain Inventory

All participants completed the BPI severity (4 items) and interference subscales (7 items; (214, 215)) and the mean scores were calculated across each subscale to give an overall indication of pain severity and pain interference.

The definition and ascertainment of falls

A fall was defined as ‘*an unexpected event in which the participants come to rest on the ground, floor, or lower level*’ (56). The total number of falls over the past 12 months was recorded and respondents classified as non-, single or recurrent fallers (209). In order to negate the risk of reverse causality, all participants that had CMP were asked ‘*did your current pain arise following from a fall?*’. Participants answering yes were excluded from the analysis.

Functional mobility assessment

All participants underwent the timed up and go test (220) and the time taken was measured in seconds and scores represent functional mobility (221).

Falls efficacy and fear of falling

For the current study, all participants completed the short form Short FES-I (254)). The Short FES-I scores range from 7 (no FOF) to 28 (very fearful of falling) and its psychometric properties have been established (226, 254).

Sedentary Behaviour

The IPAQ-SF was used to capture sedentary behaviour for each participant (see research methods chapter 6 for more details).

Statistical analysis

All data for the current results chapter were analysed using SPSS version 20 (SPSS inc Chicago, USA). The Shapiro-Wilks and Levene's tests were used to assess normality and homogeneity of variance of the data (244). When satisfied; an independent t-test was used to analyse differences in continuous data between groups. When these assumptions were not met, non-parametric equivalents were used. A Chi-square test was used to analyse categorical data between groups. In order to establish if compared to the comparison group, older adults with CMP were more likely to experience a) any (≥ 1), b) single and c) recurrent falls, the odds ratio (OR) adjusting for age and gender was calculated (Research question 1). Next, the adjusted OR was investigated for a) any (≥ 1), b) single and c) recurrent falls comparing those with chronic single and multisite CMP separately against the comparison group (Research question 2). In order to establish if medication (mean number), comorbidities (mean number), self-rated HRQOL (0-100; EQ-5D-5L) and mobility limitations (TUG scores) influenced the association; these were subsequently adjusted for (in addition to age and gender) for all logistic regression analysis (adjustment 2). Finally, adjustment was made for IPAQ-SF and short FES-I scores in addition to the factors adjusted for previously (adjustment 3).

Finally a receiver-operator curve (ROC) analysis using the area under the curve (AUC) was utilised to determine an optimal cut-point in BPI to discriminate between a) non-fallers and any fallers and b) recurrent fallers and non- and single fallers and c) recurrent fallers and non-fallers only (Research question 3). Sensitivity was defined as the percentage of recurrent fallers who were correctly identified and specificity was defined as the percentage of non-recurrent fallers that were correctly identified (142). In line with previous research investigating the discriminative ability of different falls measures (255) established cut off

points for the BPI subscales were based on the optimal trade-off between sensitivity and specificity.

Sample size calculation

An a priori sample size calculation was conducted using G* power software. Using a Z test to compare the proportion of fallers for those with CMP (0.5 (230)) and without (0.3 (55)), an a priori alpha of 0.05 was set with power at 0.8 and the two tailed calculation demonstrated that 93 people were needed in each group.

8.3 Results

Participant demographics

Out of a total of 401 eligible participants that were invited, 295 older adults had eligible data for the current results paper. Reasons for not taking part were reported in the first results chapter (page 195).

Key characteristics in the chronic musculoskeletal pain and comparison group

From the study participants, 154 participants (52.2%) were categorised as having CMP and 141 (47.8%) did not and formed the comparison group. There was no significant difference in the mean age or proportion of females between the CMP and comparison group (see table 8.1). The mean duration of CMP was 6.6 years (range 0.4-50 years), 64 (41.6%) persons had single site pain whilst 90 (58.4%) reported multisite CMP. Full details of the CMP and comparison groups are presented in table 8.1.

Table 8.1 Comparison of the baseline characteristics of those with chronic musculoskeletal pain and comparison group

<i>Variable</i>	<i>Control Group n=141</i>	<i>Chronic musculoskeletal pain n=154</i>	<i>P value</i>
<i>Demographic</i>			
Age (years + SD)	76.6±8.5	78.4±7.8	0.07
Females n. (%)	95 (67.4)	101 (65.6)	0.805
Live in warden accommodation n (%)	42 (29.8)	72 (46.8)	0.001
<i>Medical history and medication risk factors</i>			
Cardiac comorbidity n. (%)	23 (16.3)	62 (40.3)	<0.001
Respiratory comorbidity n. (%)	18 (12.8)	34 (22.1)	0.046
Osteoarthritis n. (%)	35 (24.8)	101 (65.6)	<0.001
Degenerative disc/ spinal problems n. (%)	14 (9.9)	39 (25.3)	<0.001
Number of comorbidities n. ± SD	2.75±1.3	3.94±1.2	<0.001 π
Number of medications	2.9 (±2)	3.6 (±)	<0.0001
<i>Functional, balance, strength risk factors</i>			
Walking aid use n. (%)	36 (25.5)	98 (63.6)	<0.001
Timed up and go >13.5sec	26 (18.4)	72 (47.1)	<0.001
Sedentary behaviour hours± SD	7.9±3.7	11.0±3.36	<0.001
<i>Health related quality of life</i>			
Overall health state (0-100, mean, SD)	79.8±15.6	58.3.±20.6	<0.001
<i>Psychological concerns related to falls</i>			
Short FES-I (mean, SD)	9.4±3.1	15.1±4.8	<0.001 π
<i>Falls history</i>			
Any falls in last 12 months (%)	47 (33.3)	90 (58.4)	<0.001
Single faller's n (%)	33 (23.4)	45 (29.2)	0.240
Recurrent faller's n (%)	14 (9.9)	45 (29.2)	<0.001
<i>Chronic Pain classification</i>			
Duration years mean(range)	-	6.6 (0.4-50)	
Single site n (%)	-	64 (41.6)	
Multisite n (%)	-	90 (58.4)	
Pain caused by previous fall? n (%)	-	9 (5.8)	

Key for table 8.1: π Non parametric test; n=number, FES= falls efficacy scale international

*Falls in older adults with chronic musculoskeletal pain compared to the comparison group –
Research question 1*

The adjusted OR investigating the association between those with CMP and any (≥ 1), single and recurrent falls are presented in table 8.2. In summary, the odds of any fall (≥ 1) in the CMP group were higher than the comparison group when adjusted for age and gender (adjustment 1, OR 2.60, 95% CI 1.60-4.24)), at the second adjustment for medical and mobility factors (OR 1.88, CI 1.05-3.36) but not when adjusted further for sedentary behaviour and short FES-I scores (adjustment 3; OR 1.49, CI: 0.80-2.75). The odds of single falls were not increased in those with CMP. The odds of recurrent falls were higher in the CMP group at each adjustment and remained elevated in the fully adjusted model (OR 2.25, CI 1.03-4.88).

The odds of falling according to the number of sites of pain – Research question 2

Next data were analysed for those with single and multisite CMP separately. The odds of any (≥ 1), single or recurrent falls was not increased for those with single site pain. The odds of those with multisite CMP experiencing recurrent falls was consistently increased in each model and in the fully adjusted model the was OR 3.43 (CI: 1.34-8.65) (see table 8.2).

Table 8.2 The Adjusted Odds of falling according to pain category

Pain categorisation	Any falls pooled AOR for risk of falls and 95% CI	Single falls and 95% CI	AOR Recurrent falls AOR and 95% CI
Pooled Chronic musculoskeletal pain 1	2.60 (1.60-4.24)*	1.37 (0.80-2.35)	3.13 (1.63 – 6.0)*
Adjustment 2	1.88 (1.05-3.36)*	1.08 (0.56-2.07)	2.53 (1.19-5.38)*
Adjustment 3	1.49 (0.80-2.75)	0.90 (0.46-1.76)	2.25 (1.03-4.88)*
Single site pain 1	1.83 (0.97-3.43)	1.34 (0.67-2.65)	1.97 (0.85-4.56)
Adjustment 2	1.50 (0.72-3.13)	1.21 (0.54-2.69)	1.64 (0.62-4.32)
Adjustment 3	1.18 (0.56-2.56)	1.05 (0.46-2.39)	1.40 (0.51-3.78)
Multisite pain 1	3.53 (1.97-6.34)*	1.39 (0.74-2.59)	4.22 (2.08-8.56)*
Adjustment 2	2.36 (1.15-4.85)*	0.98 (0.44-2.10)	3.56 (1.46-8.67)*
Adjustment 3	1.92 (0.89-4.13)	0.78 (0.33-1.81)	3.43 (1.34-8.65)*

Key table 8.2: * = p<0.05, 1=adjusted for age and gender; Adjustment 2 – age, gender, number of chronic conditions, number of prescribed medications, HRQOL and TUG scores; Adjustment 3 as above and IPAQ and FOF

The Brief Pain Inventory discriminative ability to differentiate between fallers and non-fallers-Research question 3

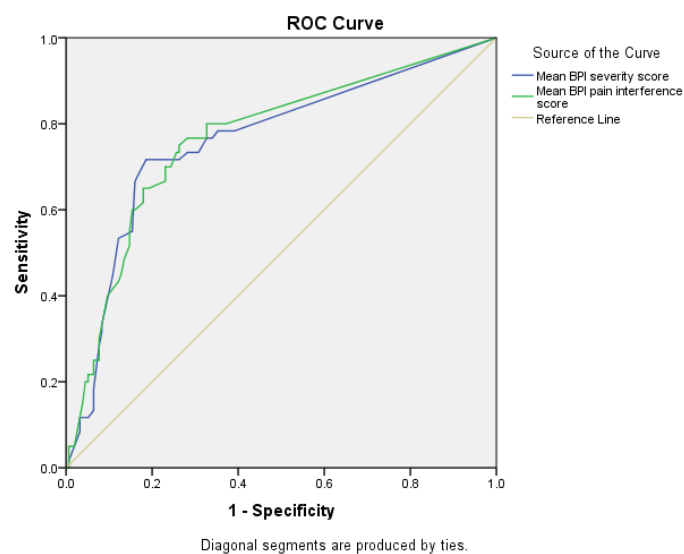
The participants with CMP (n=154) mean scores on the BPI pain severity and BPI interference subscales were 5.6 (\pm 1.8) and 4.7 (\pm 1.9) respectively. The AUC for the BPI severity subscale to discriminate any falls and non-fallers was 0.665 (95% CI: 0.576- 0.753, n=154) and a BPI score of 5.1 had a sensitivity of 71.0% and a specificity of 56.7%. The AUC for the BPI interference subscale was 0.663 (95% CI 0.575-0.751) and a score of 4.5 on the BPI had a sensitivity of 71.1% and specificity of 55.1%.

The Brief Pain Inventory discriminative ability to differentiate between recurrent fallers and non-fallers

Next, data were compared for the ability of the BPI to discriminate between recurrent fallers vs. non-fallers and single fallers together (n=154). The AUC for the BPI severity subscale was 0.679 (CI: 0.594-0.763) and a score of 5.3 had a sensitivity of 86.7% and specificity of 56.0%. The AUC for the BPI interference subscale was 0.684 (CI: 0.600-0.769) and a score of 4.7 had a sensitivity 82.2% and specificity of 55.0%.

Finally, data were compared for the discriminative ability of the BPI comparing recurrent fallers versus non-fallers only (n=109) (figure 8.1). The AUC for the BPI severity subscale was 0.731, (CI: 0.635-0.826) and a score of 5.1 had a sensitivity of 93.3% and specificity of 56.7%. The AUC for the BPI interference subscale was 0.724 (CI: 0.630-0.818) and a cut off score of 4.6 had a sensitivity of 84.4% and specificity of 57.8%.

Figure 8.1 ROC and AUC for the BPI Severity (AUC=0.731, 95% CI: 0.635-0.826) and Interference subscales (AUC=0.724, 95% CI: 0.630-0.818) to discriminate between recurrent fallers and non-fallers only (n=109).



8.4 Discussion

The current results chapter found that after multiple adjustments for potential confounders, the odds of recurrent falls were significantly increased in older adults with CMP (OR 2.25, CI: 1.03-4.88). However, this risk was greatest in those with multisite CMP (OR 3.43, CI: 1.34-8.65). Interestingly, the odds of falling (any, single or recurrent) was not increased in older adults with single site CMP. The results support previous research that has investigated falls in older adults with CMP (11). In addition, the results concur with previous research that chronic pain (although assessed through a single question; (163)) is more strongly associated with recurrent falls compared to single or any falls. This relationship has also been demonstrated in non-chronic pain (i.e. < 3 months) by other authors previously (162, 256) although none assessed pain in accordance with pain assessment guidelines (13). For instance, Kitayuguchi et al (256) found that multisite musculoskeletal pain was particularly associated with recurrent falls but the authors relied upon a single question assessing pain over the last week.

The prevalence of CMP in the current study (52%) is in line with recent research (11, 13). Specifically over half of those with CMP were affected by multisite pain (58.4%) and this group were more likely to have any (≥ 1) and recurrent falls. Reasons for the particularly increased risk of recurrent falls in older adults with CMP are likely to be complex since falls are typically multifactorial (55, 138). However, it may be that pain increases the risk of falls in the long term by accelerating the process of functional decline (15) thus impairing balance and increasing an older person's propensity to fall. Both balance and functional mobility are strongly related to falls (58, 61). In addition, previous research has clearly linked increasing pain severity to the risk of falls the following month (11) thus suggesting that in the shorter term pain severity may have a more imminent effect on increasing falls risk. Factors potentially underlying the pain-falls relationship may include local joint pathology (e.g.

osteoarthritis, (134)), the neuromuscular effects of pain and more central mechanisms whereby pain interferes with cognition (11). The current results chapter shows that in those with CMP, recurrent falls were experienced by 29.2% which is higher than previously reported in other chronic pain samples (e.g. (163)). However, no previous study has clearly assessed CMP and recurrent fall rates have been reported to be as high as 25% in people of a comparable age (aged 80 years) and above in the general population (138, 149).

In the results, it was also found that the BPI severity and interference subscales had a moderate ability to discriminate between fallers and non-fallers with an AUC of 0.665 (95% CI: 0.576- 0.753) and 0.663 (95% CI 0.575-0.751) respectively. This is higher than previous research investigating more traditional falls screening tools including the TUG (AUC 0.61, (257)), the Berg Balance Scale (AUC 0.59, (258)) and Tinetti balance scale (AUC 0.56, (257)) but lower than a functional gait assessment (FGA; AUC 0.87, (259)). The BPI severity and interference subscales may be more useful to discriminate between non and recurrent fallers since the AUC for the BPI severity and interference subscale was higher than previously reported tools for recurrent falls in the literature including the LASA (Longitudinal Aging Study Amsterdam falls risk tool) instrument (AUC: 0.71, CI: 0.67–0.74; (140)), lower limb strength (AUC 0.58, CI: 0.51–0.64, (142)) and mediolateral sway (AUC 0.67, CI: 0.57–0.77, (142)). This is of great interest as preventing recurrent fallers is an international priority (61). With this in mind, the BPI severity (4 items) or interference (7 items) could be considered in clinical practice as a falls screening measure for older adults identified as having CMP as it is quick and may prove useful in identifying those at greatest risk of recurrent falls. However, future prospective research is clearly required to better understand these relationships.

Limitations

A number of limitations should be considered with the results of this chapter. First, the results relied upon retrospective recall of falls from the sample. Although numerous authors (51, 145, 162, 163, 256) have used this approach, there are concerns about the accuracy of this method and in particular recall bias (56). Whilst recall bias may cast some doubt about the accuracy of the overall number of falls in the sample, there is no reason to believe that any potential recall bias would be different for those with CMP and the comparison group. Moreover, the current results chapter went further than any previous study on this topic and specifically excluded participants who reported they had pain from a previous fall. Second, despite these attempts, it is not possible to completely rule out reverse causality in the relationship between pain and falls.

Future Research

Future research beyond the PhD is needed to establish if screening with the BPI can help identify and reduce the risk of falls and in particular recurrent falls in community dwelling adults. Future research should prioritise the prospective measurement of falls (56) and should consider not only the influence of the number of pain sites but also the influence of CMP location. A randomised control trial is warranted to establish if pain management interventions can reduce the occurrence of falls in older adults with CMP. Given the potential for pain interference when measured through the BPI to identify those most likely to fall, research is required to understand how it may influence concerns related to falls.

8.5 Summary of chapter

The current results chapter has for the first time attempted to disentangle the relationship between number of CMP sites and recurrent falls. In addition to establishing that those with multisite CMP are at greatest risk of recurrent falls, the results chapter demonstrates that the BPI scale may help identify those most at risk. Given the importance of pain interference on falls risk, the next chapter will investigate how this influences each of the psychological concerns related to falls.

CHAPTER 9

THE INFLUENCE OF PAIN INTERFERENCE ON PSYCHOLOGICAL CONCERNS RELATED TO FALLS

This chapter is based on the published paper:

Stubbs B, Eggermont LH, Patchay S, Schofield PA. (2014). Pain interference is associated with psychological concerns related to falls in community-dwelling older adults: multisite observational study. *Physical Therapy*, Oct; 94(10):1410-20.

This chapter relates to primary aim 2.

Overview of the chapter

The literature review chapter (chapter 3) established that no author had set out with the primary aim to investigate the relationship between pain interference and any of the psychological concerns related to falls in community dwelling older adults. The literature review also established that pain interference is associated with mobility limitations and the previous results chapter identified an increased risk of falls. Therefore, the current results paper set out to conduct the first study to investigate the relationship between pain interference and each of the four common psychological concerns related to falls. The results found that pain interference is a unique predictor for falls efficacy, balance confidence, the avoidance of activities due to FOF and concerns about the consequences of falling in the sample. Moreover, given the results of the previous chapter, subgroup analyses were conducted to investigate the influence of falls history on the results.

9.1 Introduction

Psychological concerns related to falls, such as FOF, avoiding activities due to a FOF, reduced falls efficacy and balance confidence are common and troublesome phenomena among community dwelling older adults (43, 46, 47). Restricting ones physical activity due to an actual increased risk of falling may in the short term prove functional, however when this is disproportionate to a person's physical capabilities it can result in sensorimotor deconditioning, reduced balance and actually increase a person's risk of falls (40, 41). In addition, avoiding activities due to concerns related to falling can increase social isolation, reduce quality of life and is associated with depressive symptoms (40, 41, 44, 45). To this end, the first results chapter (chapter 7) established this may increase sedentary behaviour. Although psychological concerns are highly prevalent in people who have fallen, many people who do not have a history of falls are also affected. For instance, a large population based study (47) involving 926 older adults found that 70% of participants who reported FOF did not have a history of falls within the previous year. Overall, the prevalence of psychological concerns related to falls is high among community dwelling older adults with up to 85% being affected (46).

Within the literature, a range of psychological concern related to falls have been identified and commonly include FOF and avoiding activities due to FOF, falls efficacy, balance confidence and disproportionate concerns about the consequences of falling over (41, 44, 111). FOF has been defined as a lasting concern about falling that leads to an individual not performing activities they are capable of doing (112). Falls efficacy stems from Banduras' (113) concept of self-efficacy and refers to an individual's perception of their own self efficacy to avoid a fall (41). Balance confidence captures an individual's confidence of maintaining their balance and not falling over when undertaking their ADL (114). More recently, there has been interest in looking at another dimension which investigates if an

individual has disproportionate concerns about the consequences of falling (COF) (49). For the purposes of this chapter, these measures will collectively be referred to as ‘psychological concerns related to falls’.

To date a range of risk factors for psychological concerns related to falls have been identified within the general older adults literature including actual falls, increasing age, female gender, dizziness, mobility difficulties and reduced lower limb function (41, 43, 44, 111). The identification and management of risk factors is important since it empowers clinicians to employ strategies to address these. One potential risk factor that has received relatively little attention to date is pain, which is surprising for several reasons. First, pain is associated with mobility limitations (25) balance deficits and difficulties with gait (21, 24, 260) all of which are strongly linked to FOF (43) and actual falls (11). Second, pain is highly prevalent in community dwelling older adults with up to 76% being affected (13). Third, fear of movement and in particular fear avoidance due to pain have been strongly implicated in the pain literature for some time (48) but the association of avoiding activities due to FOF as a result of pain has gone relatively unnoticed. The second literature review chapter (chapter 3) found that no author had set out with the primary aim to investigate the influence of pain on psychological concerns related to falls. However, the chapter did report that most studies found a statistically significant association but that very few authors used a validated pain assessment scale, thus bringing into question the reliability of the results.

Given the fact that pain and psychological concerns related to falls are both highly prevalent and burdensome, it is important research is conducted to consider if pain contributes to psychological concerns related to falls. Since the previous results chapter (chapter 8) found pain that interferes with ADL is particularly troublesome and associated with falls (261) and psychological concerns related to falls in particular (225), the current results chapter focused on pain interference.

The aims of the current chapter are two-fold:

1) to establish if pain interference, measured by the BPI pain interference subscale (BPI,(214, 215)) is correlated with each of the four common psychological concerns related to falls among the sample of community dwelling older adults.

2) to investigate if pain interference contributes to psychological concerns related to falls over and above previously established risk factors (increasing age, female gender, dizziness, comorbidity, poly-pharmacy, wearing glasses, mobility limitations) and remains a unique predictor in the fully adjusted model.

Furthermore, the previous results chapter (chapter 8) and literature review chapter (chapter 4) established that pain is associated with falls. Therefore, a sensitivity analysis was conducted taking into account falls history when investigating the association between pain interference and psychological concerns related to falls.

The specific hypotheses were that pain interference would a) be highly correlated and b) a significant predictor to each of the psychological concerns related to falls (FOF and avoidance of activities due to FOF, falls efficacy, balance confidence and COF).

9.2 Method

Study Design and setting

The current results chapter utilised a cross sectional multisite study across the 10 participating centres in the UK. The recruitment, setting and procedure was described in the first results chapter (chapter 7) and research methods chapter in detail (chapter 6).

Participants

Details regarding the participant's eligibility criteria and recruitment were described in the research method chapter and in the first results chapter.

Assessment

Demographic and background variables

The information required for the current study including age and gender in addition to the mean number of self-report physician diagnosed comorbidities and medications. Moreover, details regarding dizziness and falls history were used in the current study.

Mobility

All participants underwent the TUG test in order to assess each individual's functional balance and mobility (220). The time taken to complete the TUG was recorded in seconds and scores are related to falls (262) and psychological concerns related to falls (263).

Pain interference upon activities of daily living

The current study focussed on pain interference which was ascertained using the validated BPI scale (214, 215). Previous research (24) has identified that pain interference is associated with marked ADL disability and the literature review chapter (chapter 3) identified

pain interference appears to be more strongly related to psychological concerns related to falling. Therefore, this research only used the mean scores from the 7 item BPI interference subscale. The BPI interference subscale asks participants to rate how their pain has interfered with 7 activities on an 11 point scale (0=no interference – 10 =completely interferes). The 7 activities covered include the influence of pain on (1) general activity, (2) mood, (3) walking ability, (4) normal work, (5) relations with over people, (6) sleep and (7) enjoyment of life. The average score was calculated for the BPI interference subscale for the whole sample in accordance with previous research (24) and used as a predictor for the psychological concerns related to falls dependent variables.

Psychological concerns related to falls

Each participant completed the following measures Short FES-I, ABC scale, MSAFFE and COF scales which capture falls efficacy, balance confidence, avoidance of activities due to FOF and concerns about the consequences of falling respectively. Full details regarding each of these measures including psychometric properties is given in the research methods chapter (chapter 6).

Data analysis

All data analysis were conducted with SPSS version 20 (SPSS inc Chicago, USA). Continuous data was assessed for normality and data that were skewed (BPI pain interference subscale and TUG scores) were log transformed for the analysis. In order to establish the association between each of the psychological concerns related to falls and the mean BPI interference subscales a Pearson correlational analysis was conducted. A significance level of $p < 0.05$ was set (research aim 1).

Second, a hierarchical multiple regression analysis using each of the four psychological concerns related to falls as the dependent variable (Research aim 2). In the first step socio-demographic and established risk factors established from the literature were entered into the model including age, gender, dizziness, comorbidity, poly-pharmacy, wearing glasses and mobility/ lower limb strength (TUG scores). In the second step, the mean BPI interference subscale scores were entered into the model so that it would be possible to ascertain the unique contribution to the variance within each of the psychological concerns related to falls, which was reported as a change in R^2 . Within the final model the standardised beta coefficients for each independent variable are reported to establish which variables were significant predictors of the psychological concerns related to falls after adjusting for all other factors. In order to assess the potential modifying effect of a history of falls on the variance explained within each of the models within the psychological concerns related to falls, a subgroup analysis was conducted comparing those with a history of falls and without. Within this analysis, a history of falls was removed from the model as a predictor. In order to assess for multicollinearity, the VIF and tolerance were calculated for each model ensuring this was within satisfactory ranges (VIF <10 and not much higher than 1; and tolerance > 0.2; (244)).

Sample size calculation

An a priori sample size calculation was conducted using the G power software. Based upon an R^2 increase with 9 predictors in the model, a power of 0.8, significance level at 0.05 and a medium effect size ($F^2=0.15$) a total sample size of 55 was required. Therefore, the current results chapter was adequately powered.

9.3 Results

Participant details

From the potential 401 participants that were approached, 295 agreed to participate and had complete data for the current results chapter (response rate 73.5%). Of the participants that took part, the mean age was 77.5 years and two thirds were female (66.4%). Almost half of respondents experienced dizziness (46.7%) and used a walking aid (45.4%) and participants had on average 3.4 comorbidities and took 3.8 medications. Full details of the participant demographics for the current chapter are presented in table 9.1.

Table 9.1: Details of included participants and results of main outcome measures

Variable	Number (95% CI, percentage or range)
<i>Age (years)</i>	77.5 (76.7-78.6)
<i>Gender (female)</i>	196 (66.4%)
<i>Dizziness</i>	138 (46.7%)
<i>Wear glasses (yes)</i>	182 (61.7%)
<i>Use a walking aid (yes)</i>	134 (45.4%)
<i>Osteoarthritis (yes)</i>	136 (46.1%)
<i>Rheumatoid arthritis (yes)</i>	6 (2.0%)
<i>Osteoporosis (yes)</i>	51 (17.3%)
<i>Number of comorbidities</i>	3.4 (3.2-3.5)
<i>Number of medications</i>	3.8 (3.5-4.0)
<i>Timed up and go scores (sec)</i>	11.8 (5.9-41.8) π^*
<i>History of falls</i>	138 (46.8%)
<i>BPI interference</i>	1.7 (0-9.3) π
<i>BPI severity subscale</i>	2.5 (0-10)
<i>Short FES</i>	12.4 (11.8-13.0)
<i>ABC</i>	59.4 (56.6-62.2)
<i>COF</i>	28.9 (28.1-29.6)
<i>MSAFFE</i>	25.2 (24.3-26.1)

Key for table 9.1: *=1 participant info missing, π =data not normally distributed and log transformed for analysis, 95% CI= 95% confidence intervals.

Almost half of the respondents had experienced one or more falls in the previous year (46.8%). The median for the BPI interference subscale for the sample was 1.7 (range 0-9.2). In total, one hundred and sixty nine participants reported some degree of pain interference over the previous two weeks (57.3%). Each of the psychological concerns related to falling scores for the sample is presented in table 9.1. The mean BPI interference subscale scores were highly correlated to the short FES-I scores ($r=0.643$, $p<0.01$), ABC scores ($r=-0.529$, $p<0.01$), MSAFFE scores ($r=0.515$, $p<0.01$) and COF scores ($r=0.561$, $p<0.01$). Although never intended, it was not possible to also insert the BPI severity subscale scores into the model as this violated the assumptions for multicollinearity (VIF and tolerance).

The influence of Pain interference on Falls efficacy

The socio-demographic and established risk factors explained a significant amount of the variance within the short FES-I scores ($F_{[8, 285]} = 21.907$, $p<0.0001$, $R^2=0.381$, adjusted $R^2=0.363$). The introduction of the BPI interference subscale at step 2 contributed to a significant increase in variance explained within the short FES-I scores from 38.1% to 51.8% with an adjusted $R^2= 0.50$ which was a significant change of 13.2% ($F_{[1, 284]}= 80.728$, $p<0.001$). Within the final model, the BPI interference score made the largest unique contribution to the model ($\beta=0.455$, $p<0.0001$) followed by the TUG scores ($\beta=0.220$, $p<0.0001$) and the number of comorbidities ($\beta=.121$, $p=0.05$). The standardised beta-coefficients for the final model and unique contribution of each of the independent variables are presented in table 9.2.

Next, a subgroup analysis was conducted to see if the variance explained within the FES scores in the fully adjusted model differed between those with and without a history of falls. In those without a history of falls the variance explained in the model was 45.5% (adjusted R^2

0.425, $F_{[8, 147]} = 15.32$, $p < 0.001$). The variance explained within the fully adjusted model among those with a history of falls was 52.8% (adjusted $R^2 0.499$, $F_{[8, 127]} = 18.0$, $p < 0.001$).

Table 9.2: Summary of hierarchical regression analysis for variables predicting Short FES scores

Variable	Step 1			Step 2		
	<i>B</i>	<i>SE B</i>	β	<i>B</i>	<i>SE B</i>	β
Constant	3.375	2.390		2.755	2.114	
Age	-.009	.031	-.015	.026	.028	.042
Gender	.323	.505	.031	.316	.446	.030
Dizziness	.492	.176	.132**	.303	.157	.081
Comorbidity	.760	.241	.216**	.424	.216	.121*
Number of medications	.206	.160	.090	.083	.142	.036
Wear glasses	.351	.491	.034	.241	.434	.023
History of falls	1.156	.305	.185***	.328	.285	.053
TUG scores	.272	.048	.315***	.190	.043	.220***
BPI interference scores				.812	.090	.455***

Key for table 9.2: * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$, *B* and *SE* (standard error) *B* = unstandardized coefficients, β = standardised beta coefficients. Variables entered into the model at step 1 = Age, gender, dizziness, number of comorbidities, number of medications, currently wear glasses, history of falls, TUG scores. Step 2 = All of the variables at step 1 and the BPI interference subscale.

The influence of pain interference on Balance confidence

The background and established risk factors significantly explained a large amount of variance within the ABC scores ($F_{[8, 282]}=39.175$, $p<0.0001$, $R^2=0.526$, adjusted $R^2=0.513$). The introduction of the BPI interference subscale scores at step 2 resulted in a significantly increased amount of variance being explained within the ABC scores from 52.6% to 57.3% with an increase in the adjusted R^2 of 0.559, an increase of 4.7% of variance in the model ($F_{[1,281]}= 30.721$, $p<0.0001$). Within the fully adjusted model, the TUG scores made the largest significant contribution ($\beta=-.396$, $p<0.0001$) followed by the BPI interference subscale ($\beta=-.265$, $p<0.0001$), the number of medications a person is taking ($\beta=-.166$, $p=0.002$) and age ($\beta=-.133$, $p=0.005$). The summary regression model for the ABC scores are presented in table 9.3.

Table 9.3: Summary of hierarchical regression analysis for variables predicting ABC scores

Variable	Step 1			Step 2		
	<i>B</i>	<i>SE B</i>	β	<i>B</i>	<i>SE B</i>	β
Constant	128.026	10.464		129.370	9.955	
Age	-.313	.137	-.103*	-.404	.131	-.133**
Gender	.333	2.188	.006	.332	2.082	.006
Dizziness	-1.708	.754	-.094*	-1.170	.723	-.064
Comorbidity	-2.134	1.038	-.124*	-1.151	1.003	-.067
Number of medications	-2.198	.689	-.196**	-1.852	.659	-.166**
Wear Glasses	-.703	2.124	-.014	-.411	2.021	-.008
History of falls	-2.154	1.325	-.070	.157	1.327	.005
TUG scores	-1.902	.206	-.450***	-1.675	.200	-.396***
BPI interference scores				-2.314	.418	-.265***

Key table 9.3: *= $p<0.05$, **= $p<0.01$, *** = $p<0.001$, B and SE (standard error) B= unstandardized coefficients, β = standardised beta coefficients. Variables entered into the model at step 1 = Age, gender, dizziness, number of comorbidities, number of medications, currently wear glasses, history of falls, TUG scores. Step 2 = All of the variables at step 1 and the BPI interference subscale.

In the subgroup analysis, the variance explained within ABC scores in those without a history of falls was 54.5% (adjusted R^2 0.521, $F_{[8, 147]}= 22.0$, $p<0.001$). The variance explained in ABC scores in people with a history of falls was 61.1% (adjusted R^2 0.586, $F_{[8, 127]}= 24.7$, $p<0.001$).

The influence of pain interference on fear of falling and avoidance of activities due to FOF

The background and established falls risk factors explained a significant amount of variance within the MSAFFE scores within the sample ($F_{[8, 283]}= 25.954$, $p<0.0001$), $R^2=0.423$, adjusted $R^2=0.407$). Upon step 2, the BPI interference resulted in a statically significant increase in variance explained from 42.3% to 47.3% within the MSAFFE scores with an R^2 change of 5.0% ($F_{[1,282]}= 26.830$, $p<0.0001$). Within the fully adjusted model, the TUG scores were the strongest predictor of MSAFFE scores ($\beta=.343$, $p<0.0001$), followed by the BPI interference subscale ($\beta=.276$, $p<0.0001$), the number of comorbidities ($\beta=.140$, $p=0.03$) and age ($\beta=.106$, $p=0.027$). The standardised beta-coefficients of the final model are presented in table 9.4.

Table 9.4: Summary of hierarchical regression analysis for variables predicting FOF and avoidance of activities due to FOF

Variable	Step 1			Step 2		
	B	SE B	β	B	SE B	β
Constant	3.628	3.652		3.014	3.498	
Age	.069	.048	.072	.102	.046	.106*
Gender	1.387	.774	.083	1.379	.741	.082
Dizziness	.474	.268	.081	.297	.259	.050
Comorbidity	1.082	.369	.195**	.774	.358	.140*
Number of medications	.147	.245	.041	.020	.235	.006
Wear glasses	-.140	.754	-.009	-.216	.722	-.013
History of falls	1.507	.466	.153***	.713	.472	.072
TUG scores	.548	.073	.402***	.468	.071	.343***
BPI interference scores				.777	.150	.276***

Key for table 9.4: *= p<0.05, **= p<0.01, *** = p<0.001, B and SE (standard error) B= unstandardized coefficients, β = standardised beta coefficients. Variables entered into the model at step 1 = Age, gender, dizziness, number of comorbidities, number of medications, currently wear glasses, history of falls, TUG scores. Step 2 = All of the variables at step 1 and the BPI interference subscale.

The variance explained within MSAFFE scores was 45.4% (adjusted R^2 0.424, $F_{[8, 147]}= 15.2$, p<0.001) in people without a history of falls and 44.4% (adjusted R^2 0.409, $F_{[8, 127]}= 12.7$, p<0.001) among people that had fallen in the past 12 months.

The influence of pain interference on concerns about the consequences of falling

The background and established risk factors significantly explained 31.8% of the variance within the COF scores ($F_{[8, 283]}= 16.517, p<0.0001, R^2=0.318, \text{adjusted } R^2=0.299$). In the second stage the addition of the BPI interference subscale resulted in an increased explanation of the variance in the COF scores from 31.8% to 41.8% with an R^2 change of 10.0% ($F_{[1, 282]}=48.477, p<0.0001$). Within the final model, the BPI interference made the largest unique contribution to COF scores ($\beta=.390, p<0.0001$), followed by TUG scores ($\beta=.198, p<0.0001$) and male gender ($\beta=.117, p=0.012$) (see table 9.5).

Table 9.5: Summary of hierarchical regression analysis for variables predicting concerns about the consequences of falling

Variable	Step 1			Step 2		
	B	SE B	β	B	SE B	β
Constant	15.817	3.217		15.115	2.979	
Age	.005	.042	.006	.042	.039	.054
Gender	1.596	.682	.118*	1.587	.631	.117*
Dizziness	.311	.236	.065	.108	.221	.023
Comorbidity	.827	.325	.184*	.474	.305	.105
Number of medications	.289	.216	.099	.143	.201	.049
Wear glasses	-.225	.665	-.017	-.312	.615	-.024
History of falls	1.312	.411	.164**	.403	.402	.050
TUG scores	.310	.064	.281***	.219	.061	.198***
BPI interference scores				.889	.128	.390***

Key for table 9.5: *= $p<0.05$, **= $p<0.01$, *** = $p<0.001$, B and SE (standard error) B= unstandardized coefficients. Variables entered into the model at step 1 = Age, gender, dizziness, number of comorbidities, number of medications, currently wear glasses, history of falls, TUG scores. Step 2 = All of the variables at step 1 and the BPI interference subscale.

Finally, the subgroup analysis revealed that the variance within COF scores in people without a history of falls was 34.9% (adjusted $R^2 0.313, F_{[8, 147]}= 9.84, p<0.001$). The variance explained within COF scores among people with a history of falls was 46.8% (adjusted $R^2 0.435, F_{[8, 127]}= 13.9, p<0.001$).

9.4 Discussion

The current results chapter has demonstrated that pain interference is significantly associated with the short FES-I, ABC, MSAFFE and COF scales (all $r > 0.5$, $p < 0.001$). In addition, within the regression analysis, it was evident that the BPI pain interference subscale significantly increased the variance of the short FES-I scale (R^2 change = 13.2%), the ABC (R^2 change = 4.7%), MSAFFE (R^2 change = 5.0%) and COF scale (R^2 change = 10.0%) beyond factors that are commonly recognised as contributing to psychological concerns related to falls. Finally, it was established that the BPI pain interference was a significant independent predictor of each of the psychological concerns in the fully adjusted regression models. In summary, the results of the current chapter suggest that pain that interferes with ADL is an important risk factor for reduced falls efficacy, balance confidence, FOF and increased concerns about the consequences of falling. Pain interference seems to have the greatest influence on reducing falls efficacy and increasing concerns about the outcome of falling over. In the subgroup analysis, the variances explained in falls efficacy, balance confidence and consequences of falling were higher in people with a history of falls compared to those without. However, the avoidance of activities due to FOF was slightly lower in those with a history of falls. This suggests that there are some differences in the psychological concerns related to falls in those according to a history of falls, although each of the psychological concerns is clearly a factor for both groups.

There are multiple strengths to the current results chapter. First, to the researcher's knowledge, the current chapter is the only study that has investigated the influence of pain interference on all four psychological concerns related to falls in a sample of community dwelling older adults. The literature review chapter (chapter 3) identified that none of 12 studies conducted to date had an a-priori aim to investigate the influence of pain severity or interference on psychological concerns related to falls. In addition most research to date has

only investigated one of the psychological concerns related to falling offering an incomplete picture. For instance, Billis et al (120), Cumming et al (124), Hubscher et al (128) and Levinger et al (121) only investigated the influence of pain on falls efficacy and all found that pain had a deleterious impact. In addition, only one author(44) has investigated the influence of pain severity on concerns about the consequences of falling. The current results are likely to be of interest to clinicians, as disproportionate concerns about adverse consequences of falling could possibly explain the reasons for avoidance of activities due to a FOF and increased levels of sedentary behaviour for example. Only one previous study has investigated all four psychological concerns related to falls (44) but the authors relied upon the assessment of pain severity through the short form 36 bodily pain subscale which offers no information on the impact of pain on ADL and is not a validated pain assessment scale. Only three studies (122, 125, 126) have used a validated pain assessment measure but none investigated the influence of pain interference. Thus, the current study is the first to investigate the concept of pain interference upon ADL using a validated outcome measure upon all four psychological concerns related to falls. This is important as pain interference is linked to difficulties undertaking ADL and increased mobility deficits and higher risk of falls (24). Within the current study, it was established that 57.3% of participants reported pain interference over the past two weeks, which is in line with the prevalence reported in previous nationally representative research (15). The model used in the current study based on the sample data (including some people with and some without pain interference) to predict the psychological concerns related to falls is shown to be good enough to be generalisable to the general population but future prospective research is clearly required. Another strength of this chapter is that all of the measures used to capture psychological concerns related to falls have demonstrated good psychometric properties (44) and are relatively quick and easy to use in clinical practice. Since the BPI is also quick and easy to

use in clinical practice our results will be of high interest to clinicians, particularly given the results in the previous chapter regarding the ability of the BPI interference subscale to identify those at risk of recurrent falls.

Implications

The current chapter has established that in the sample of community dwelling older adults recruited, pain that interferes with ADL is strongly related to psychological concerns related to falling. Both of these phenomena are very prevalent in our ageing society and physiotherapists already have established roles in providing interventions in both of these areas. With the substantial number of people that are likely to be affected by pain, it is likely that physiotherapists will have a central role in addressing these common issues. Within the current results it was established that pain interference had the strongest relationship with lower falls efficacy and higher concerns about the consequences of falling. This may explain the lower levels of physical activity observed in the first literature review chapter (chapter 2) and higher levels of sedentary behaviour seen in the first results chapter (chapter 7). Physiotherapists and other clinicians should seek to detect pain interference promptly and prevent it from developing into chronic pain and a prolonged cycle of disuse. The relationship with pain interference and self-efficacy has been seen in other studies (e.g. (264)) but not in relation to falls self-efficacy. Physiotherapists are likely to have an influential role in not only managing the older person's pain but also in increasing self-efficacy. Previous research has demonstrated that lower self-efficacy is associated with greater disability (265) and lower physical activity in older adults with pain (266). Thus, Physiotherapists may have the dual role of managing adjustment to pain through enhancing self-efficacy in this population. Previous research (267) has demonstrated that motivational interviewing can enhance self-efficacy and increase adherence to exercise in older people with chronic pain. The importance of reduced falls efficacy on falls risk is also profound and is an indicator of

future falls independent of an individual's physiological falls risk profile (42). It appears that anxiety plays an important role and may result in an individual overestimating their falls risk possibly as a consequence of misinterpretation of small balance impairments as major deteriorations (42). However, the results were adjusted for balance and mobility scores in the analysis by inserting the TUG scores and this may have negated the impact of this to some extent upon the observed results.

Future research should seek to answer the questions it is not possible to elucidate with the current study. This should include longitudinal prospective studies to categorically determine the direction of the relationship between the variables and identify salient factors related to positive falls self-efficacy in particular. This research should also seek to ascertain validated measures of anxiety and depression as these are closely linked to the psychological concerns related to falls (40) and also pain (17). Although the statistical models in the current chapter accounted for a substantial and statistically significant amount of the variance in each of the psychological concerns related to falls, it is likely that other elements such as depression, biological and social factors may also contribute to this relationship. Future prospective research is required to further disentangle the relationship between pain interference and psychological concerns related to falls whilst also considering these other factors the current chapter did not. Research is also required to determine if physiotherapy based interventions (including those that seek to reduce pain and improve mobility) lead to a reduction in psychological concerns related to falls. More specifically, research is required to investigate musculoskeletal pain characteristics regarding balance confidence, given that balance confidence is a particularly important facet which has been demonstrated to respond to physiotherapy interventions (268).

9.5 Summary of chapter

The current chapter established for the first time that pain interference is associated with each of the psychological concerns related to falls, even when previously identified risk factor are controlled for. Given the deleterious consequences of psychological concerns related to falls, the current chapter provides important guidance for future research. The current chapter also demonstrated that there is some variation in each of these when one considers an individual's falls risk. Given its particular importance and the fact research has demonstrated physiotherapy can improve balance confidence, the next results chapter will focus on musculoskeletal pain characteristics associated with balance confidence.

CHAPTER 10

MUSCULOSKELETAL PAIN CHARACTERISTICS ASSOCIATED WITH BALANCE CONFIDENCE

This chapter is based on the published paper:

Stubbs, B., Schofield, P., Patchay, S., Leveille, S. (2015). Musculoskeletal pain characteristics associated with lower balance confidence in community dwelling older adults. Physiotherapy.

This chapter relates to primary aim 2.

Overview of the chapter

The current chapter set out to investigate the relationship between musculoskeletal pain characteristics and balance confidence. In particular, given the results from chapter 8, this results study set out to investigate if multisite and higher pain severity are associated with more pronounced deficits in balance confidence. The current study is the largest to date to investigate balance confidence and musculoskeletal pain characteristics and found that both high pain severity and multisite CMP are independently associated with CMP.

10.1 Introduction

Chronic musculoskeletal pain affects approximately 50% of community dwelling older adults (13) and is a leading cause of disability in old age, associated with mobility and ADL difficulties (15, 25). The meta-analyses conducted within the fourth literature chapter established that both CMP (particularly multisite) and pain severity are important risk factors for falls (11, 230). Recently, interest has risen in the possible impact of CMP on “psychological concerns related to falls” such as balance confidence (225). However, research specifically investigating the influence of musculoskeletal pain characteristics in this area is lacking and warrants exploration (43, 225).

Balance confidence refers to an individual’s confidence to maintain their balance and avoid falling over when undertaking their ADL (41, 44). Loss of balance confidence is a cause for concern since it may result in activity restriction which can consequently increase sensorimotor deconditioning and subsequently increase an older person’s risk of falls (41, 44, 49, 269). Furthermore, reduced balance confidence is in its own right disabling and detrimental to the wellbeing of older adults (40, 43). Among the few measures of balance confidence, one scale, the Activities and Balance Confidence scale (ABC, (114)) is favoured among clinicians and has excellent test-retest reliability ($r = 0.92$, $p < 0.001$ (114)) and internal consistency (Cronbach’s alpha = 0.96 (270)). The ABC is a 16 item questionnaire that assesses a person’s confidence in performing various functional tasks without losing their balance (114) and is able to identify those at risk of falls (44, 271).

In the second literature review chapter (chapter 3) (225) it was established that no publication was identified with a primary aim of investigating the relationship between CMP and musculoskeletal pain characteristics and balance confidence. This is despite the fact that both are common and pervasive phenomena among older adults and that musculoskeletal

pain is associated with risk factors for low balance confidence (e.g. poor mobility, history of falls (43, 44)). The literature review chapter (225) identified only one small study (96) comparing balance confidence in older adults with back pain (n=15) to those without pain (n=15). The authors (96) found that those with back pain scored lower on the ABC than those without pain. To the best of the researcher's knowledge, no other studies have addressed this important issue. However, since high numbers of community dwelling older adults are affected by CMP and also reduced balance confidence, research is required to disentangle this relationship. Specifically, research is required to investigate the impact of not only the severity of musculoskeletal pain but also to see if the number of chronic pain sites (particularly multisite pain) is an important factor for balance confidence. The literature review chapter (chapter 3) and results chapter (chapter 8) investigating CMP and falls found that multisite pain is particularly associated with recurrent falls. The previous results chapter (chapter 9) found that pain interference is associated with each of the psychological concerns related to falls but did not investigate number of pain sites. Research is required to understand if musculoskeletal pain contributes to balance confidence since this association could be influential in the impact that pain has on mobility and falls risk seen in those with CMP (21, 25, 137, 230).

The current results chapter set out to address these gaps within the literature. The specific aim of the chapter was to determine whether pain severity and number of CMP sites is associated with balance confidence. It was hypothesised that both pain severity and multisite pain contribute to loss of balance confidence after accounting for other common risk factors for lower balance confidence including demographic, medical and mobility factors.

10.2 Method

Design

Cross sectional study across 10 participating sites in the UK.

Recruitment and Participants

Details of recruitment, eligibility criteria for the quantitative study are contained within the research methods chapter in full (chapter 6).

Demographic and background variables

For the purposes of the current study details regarding participants' demographic characteristics (age, sex, currently live alone yes/ no) and medical history (mean number of self-reported physician diagnosed comorbidities and number of prescribed and over the counter medicines taken in the previous two weeks) were utilised. All participants completed the European Quality of Life Instrument (217) (EQ-5D 5L) in which participants rated their overall health state from 0 to 100 (higher scores= better HRQOL). The EQ-5D 5L has questions regarding symptoms of anxiety and depression and difficulties undertaking ADL ranging from 1 (no symptoms depression/ no difficulties undertaking ADL) to 5 (severely depressed/ unable to undertake ADL). Participants scoring >1 were classified as having depressive symptoms and difficulties undertaking ADL, respectively.

Mobility assessments

Details of participants' use of walking aids either inside or outside (yes/no) were obtained and all completed the TUG (220). History of falls in the past year was assessed; a fall was defined as '*an unexpected event in which the participants come to rest on the ground, floor, or lower level*' (56). Sedentary behaviour was ascertained using the IPAQ SF (223).

Chronic musculoskeletal pain assessment

In accordance with previous research, participants were asked if they had experienced musculoskeletal pain over the past month and also for at least 3 of the past 12 months across seven bodily locations (hands and wrists, shoulders, hips, knees, back, neck and feet (11)). Participants meeting these criteria were classified as having CMP (either single or multisite pain, 2 or more sites) and those who did not were classified as not having CMP (11).

Brief Pain Inventory

All participants completed subscales of the BPI (214)) and for the current study the mean score across the 4 items on pain severity were calculated to give an overall score of pain severity (11, 214).

Balance confidence assessment

The primary outcome measure for the current chapter is the ABC scale. The ABC scale (114) is a 16-item instrument in which participants rate their confidence in maintaining their balance when undertaking 16 functional ADL. Each question begins with “*How confident are you that you will not lose your balance or become unsteady when you...?*” On each question the participant rates the confidence they have in their balance from 0% (no confidence) to 100% (complete confidence). The mean score was calculated across the 16 items, with higher scores indicating greater confidence. More details on the ABC scale can be found in the research methods chapter.

Data analysis

All data for the current chapter were analysed using SPSS version 20 (SPSS Inc., Chicago, USA) and StatsDirect (StatsDirect Ltd, Cheshire, UK). Continuous data were assessed for normality with a visual inspection of PP plots in addition to the calculation of skew and

kurtosis (244). The BPI severity and TUG were consequently log-transformed. The ABC scores were divided in tertiles (cut off points to create 3 groups 0-33.3%, 33.4%-66.6% and >66.6% of ABC scores) to enable comparisons across groups. In addition, participants were grouped into tertiles according to the BPI pain severity scores. Secondly, participants were grouped according to the number of CMP sites: none, single site and multisite CMP. ANOVA and chi-squared tests were used to compare continuous and categorical variables between those with low, medium and high balance confidence. In order to determine the influence of pain severity and number of pain sites (none, single and multisite), separate hierarchical regression models were run with balance confidence (ABC scores) as the dependent variable. In the first step either the mean BPI severity score or number of pain sites (none, single or multisite) categories were entered together with age and gender. In the second step, model 1 and medical and HRQOL factors (number of comorbidity, number of medicines, vision, self-care, anxiety and depression and overall HRQOL) were included. In the third step, model 1+2 and mobility factors (walking aid use, history of falls, sedentary behaviour) were included. Finally, at the fourth step variables in models 1 through 3 were included in addition to TUG scores. At each step of the modelling, the standardised beta-coefficients for mean BPI severity score and number of pain site categories are reported. Multicollinearity was assessed by calculation of the VIF and tolerance for each model ensuring this was within satisfactory ranges (VIF <10 and not much higher than 1; and tolerance > 0.2; (244)). Significance was set at $p \leq 0.05$.

Sample size calculation

A sample size calculation was conducted using G power software before the commencement of the study. Using an alpha of .05, a power of .95, a model with 13 predictors and medium effect size ($F^2=0.15$) a total sample size of 189 was required.

10.3 Results

Participant characteristics

Out of 401 participants invited to take part in the quantitative phase of the thesis 295 agreed. ABC questionnaires were incomplete for 6 participants and in total 289 (response rate of 72%) older adults had complete information for this study. The average age of the sample was 77.5 years (± 8.1 years) and 195 were female (67%). Across the sample, the mean ABC score was 59% (± 24). The ABC scores were categorised into tertiles as low (n=98, ABC score 0-45.0%), medium (n=94, ABC scores 45.1-71.3%) and high balance confidence (n=97, ABC scores 71.4-100%).

In total, 150 older adults had CMP (52%) whilst 139 (48%) did not. Of those with CMP, 61 had single site (41%) and 89 had multisite CMP (59%). The mean score on the BPI severity subscale among the CMP group was 5.6 (± 1.8 , n=150). Nineteen participants without CMP reported some mild pain severity over the past two weeks on the BPI severity scale (mean BPI severity score, 0.29). Respondents were classified according to pain severity tertiles as none (n=120), moderate pain severity (n=77, mean BPI score 3.3, range 0.9-5.0) and high pain severity (n=92, mean BPI score 6.8, range 5.25-10.0).

Characteristics of participants according to balance confidence

A summary of the key socio-demographic, medical and mobility factors according to balance confidence tertiles is presented in table 10.1. People with low balance confidence tended to be older, reported more comorbidities, took more medications and had a lower HRQOL than those with high balance confidence. In addition, there were significant trends for those with lower balance confidence to be more sedentary and have poorer mobility (slower TUG scores) and a history of falls.

Table 10.1 Sociodemographic and health characteristics according to Balance Confidence groups

Variable	Low Balance Confidence (n=98)	Medium Balance confidence (n=94)	High Balance confidence (n=97)	P value
<i>Age (years, SD)</i>	80.4 (\pm 7.7)	78.0 (\pm 7.3)	74.4 (\pm 8.2)	<.001
<i>Female n (%)</i>	72 (73.5)	60 (63.8)	63 (64.9)	.29
<i>Live alone n (%)</i>	70 (71.4)	63 (67.0)	59 (60.8)	.28
<i>Vision OK or better n (%)</i>	59 (60.2)	70 (74.4)	83 (85.5)	<.001
<i>Number of comorbidities n (SD)</i>	4.2 (\pm 1.2)	3.3 (\pm 1.2)	2.6 (\pm 1.4)	<.001
<i>Number of medications n (SD)</i>	5.3 (\pm 1.8)	3.6 (\pm 1.9)	2.4 (\pm 1.8)	<.001
<i>Number with symptoms of depression and anxiety (Scores of >1-5, %)</i>	50 (51.0)	31 (32.9%)	9 (9.2%)	<.001
<i>Uses walking Aid n (%)</i>	85 (86.7)	38 (40.4)	8 (8.2%)	<.001
<i>Fallen in past year n (%)</i>	56 (57.1)	53 (56.4)	24 (24.7)	<.001
<i>Sedentary behaviour (hours per day, SD)</i>	12.7 (\pm 2.5)	9.6 (\pm 3.2)	6.3 (\pm 2.8)	<.001
<i>Timed get up and go scores (sec, SD)</i>	17.7 (\pm 6.9)	11.8 (\pm 2.9)	9.0 (2.0)	<.001
<i>Number with difficulties in Self-Care (Scores of >1-5, %)</i>	71 (72.4)	24 (25.5)	7 (7.2)	<.001
<i>Chronic Musculoskeletal pain n (%)</i>	76 (77.6)	49 (52.1)	25 (25.8)	<.001
<i>How good or bad is your health? (0-100, SD)</i>	56.7 (\pm 21.8)	68.1 (\pm 18.7)	80.6 (\pm 15.7)	<.001

Key for table 10.1 : SD= standard deviation, Difficulties in self-care score > 1 out of 5, , Depressive symptoms score > 1 out of 5, ABC= activities balance confidence scale, Tertiles: low balance confidence (ABC score 0-45.0%), medium balance confidence (ABC scores 45.1-71.3%) and high balance confidence (ABC scores 71.4-100%).

The relationship between chronic musculoskeletal pain, pain severity and balance confidence

Overall, participants with CMP (n=150) had a significantly lower ABC score (48%) compared to those without CMP (n=139; 71%) equating to a mean difference of 23 (p<.001). Table 10.1 demonstrates there was a strong and significant trend between CMP and balance confidence with higher proportions of people with low balance confidence having CMP (78%), compared to those with medium (52%) and high balance confidence (26%).

As shown in figure 10.1a, people with the most severe pain according to the BPI subscale category were much more likely to have low balance confidence compared to those with no pain. Similar findings were observed according to the number of pain sites (figure 10.1b) with the greatest proportion of people with low balance confidence being those with multisite CMP.

Figure 10.1a Balance confidence categories according to BPI pain severity categories

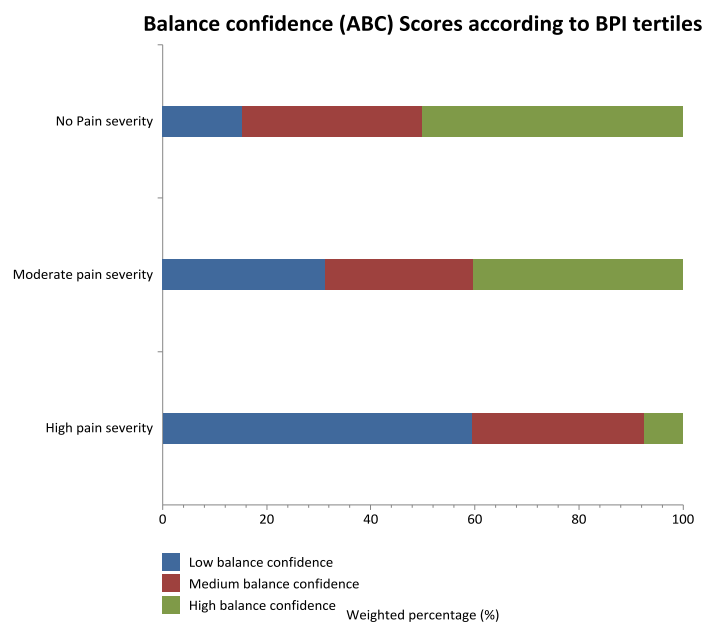
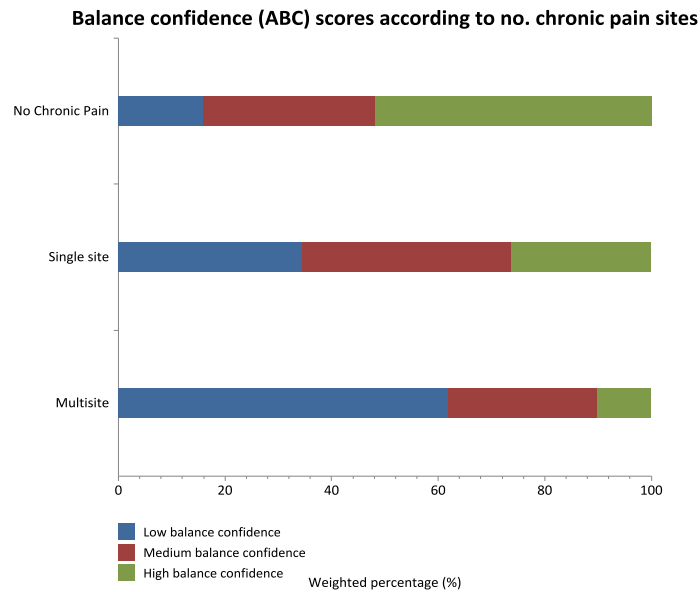


Figure 10.1b Balance confidence categories according to the number of chronic musculoskeletal pain sites



Predictors of balance confidence among older adults with musculoskeletal pain

Pain severity

In the first step of the model, pain severity (mean BPI scores) and age and gender significantly explained 39% of the variance within ABC scores ($F_{[3,287]}=60.2$, $p<.001$, $R^2=0.386$, adjusted $R^2=0.380$). After adjusting for sociodemographic, medical, mobility and HRQOL factors, pain severity continued to be inversely associated with balance confidence at the final stage of the model ($\beta=-.106$, $p=.029$).

Number of chronic musculoskeletal pain sites

At the first step of the model, the number of pain sites (none, single, multisite), age and gender explained 34% of the variance in ABC scores ($F_{[3,287]}= 48.8$, $p<.001$, $R^2 =0.338$, adjusted $R^2=0.331$). After adjusting for demographic, health and mobility factors, the number of pain sites continued to be independently associated with poorer balance

confidence ($\beta=-.98$, $p=.023$). Full details of the influence of pain severity and the number of pain sites on balance confidence at each stage of the model are summarised in table 10.2.

Table 10.2 - Hierarchical regression analysis with Balance confidence (Activities balance confidence scale scores) as the dependent variable with two separate models, one using mean BPI severity score as predictor in first step and the second using number of CMP sites (None, single or multiple).

	<i>B</i>	<i>SE B</i>	β	P value	R² change
<i>BPI pain Severity</i>					
Model 1	-4.039	.374	-.503	.000	.386
Model 2	-.970	.427	-.121	.024	.192
Model 3	-.744	.395	-.093	.061	.091
Model 4	-.852	.388	-.106	.029	.015
<i>Number of CMP sites</i>					
Model 1	-12.710	1.359	-.453	.000	.338
Model 2	-3.082	1.350	-.110	.023	.240
Model 3	-2.258	1.223	-.080	.066	.089
Model 4	-2.748	1.204	-.098	.023	.017

Key: CMP= chronic musculoskeletal pain, BPI severity= brief pain inventory severity subscale, SE= Standard error B= unstandardized coefficients, β = standardised beta coefficients, note both analysis included 289 participants

Model 1 – Mean BPI severity score OR number of CMP sites (none, single or multiple), age and gender

Model 2 – Mean BPI severity score OR number of CMP sites (none, single or multiple) + model 1 & medical and HRQOL factors (number of comorbidity, number of meds, vision, self-care, anxiety and depression and overall HRQOL)

Model 3= Mean BPI severity score OR number of CMP sites (none, single or multiple), + model 1 & 2, + mobility factors (walking aid use, history of falls, sedentary behaviour)

Model 4 = Mean BPI severity score OR number of CMP sites (none, single or multiple) + model 1-3 + TUG

10.4 Discussion

The results of the current chapter support the notion that greater pain severity and multisite CMP are associated with reduced balance confidence in community dwelling older adults. This builds on the previous results chapters demonstrating multisite pain is associated with the most marked increased risk of actual falls. Moreover in the current chapter, in a head to head comparison, older adults with CMP scored much lower on the ABC scale compared to those without CMP. The current findings show that after adjustment for multiple established risk factors for lower balance confidence (number of comorbidities, mobility difficulty, history of falls, sedentary behaviour) that pain severity and multisite CMP are associated with lower balance confidence.

The average ABC score of older adults with CMP was 48%; this low score is comparable to other populations such as those with vestibular disorders (50% (272)), those after a hip fracture (58% (273)) and adults with multiple sclerosis (66% (274)). Whilst these latter populations have traditionally been considered 'at risk' for both lower balance confidence and falls, attention has only recently started to consider these important outcomes in people with CMP. When one considers from previous research that those with CMP have profound mobility limitations (24, 25), which is a consistent risk factor for reduced balance confidence (43), this result may come of little surprise. However the associations between pain characteristics and balance confidence remained evident after adjusting for multiple other risk factors. The data demonstrates for the first time that the deficits in balance confidence seem most profound in those with multisite CMP and those with the highest pain severity. The previous results chapter also clearly demonstrated that those with multisite CMP and heightened pain severity are most likely to fall (11, 230, 275). Thus, the current study builds on this and supports the idea that clinicians should pay particular attention to older adults who have CMP for fall prevention efforts. The exact reasons for the reduced balance

confidence cannot be deduced with certainty, but may include a sense of instability leading to loss of confidence, or else similar factors proposed for the pain and falls relationship including local joint pathology, neuromuscular effects of pain, and central mechanisms, within which pain possibly interferes with cognition or executive function and therefore perceived confidence (11).

With these results in mind, clinicians could consider the available options to improve both pain and balance confidence. A recent systematic review (268) established that Tai Chi offered a medium effect size improvement in balance confidence (SMD=0.48) and was favourable above exercise and multifactorial interventions (SMD range 0.22-0.31). Tai Chi has also demonstrated a beneficial effect upon balance and falls (276) and possibly reduces pain and disability in people with chronic musculoskeletal conditions (277). Taken together, in clinical practice Tai Chi may offer favourable outcomes on several of these important domains that are commonly affected in older adults with CMP. In addition, exercise including balance and strength training can also improve balance confidence (268) and a recent umbrella review of meta-analyses of randomised control trials established that exercise is the most consistently reported effective single intervention to reduce falls in older adults (59). Physiotherapists may prove highly valuable in assessing each individual's fall risk and advising on appropriate adaptive strategies for those with more profound mobility limitations and high falls risk. Other forms of structured physical activity may also have beneficial effects on pain symptoms (39) and possible also falls (55) and injurious falls (169). However, to the best of the researcher's knowledge, no author has specifically investigated the influence of physical activity on both pain symptoms and falls in a sample of community dwelling older adults with CMP. Future research should therefore seek to achieve this.

Future research

Future prospective population-based research is needed to determine whether there is a temporal relationship whereby pain leads to lower balance confidence in older adults and should seek to identify contributing factors. Of equal importance is consideration of future interventional strategies that may not only improve balance confidence, but also improve physiological balance, reduces fall risk and improve pain symptoms among older adults living with CMP. Tai Chi shows promise when various domains are considered separately (e.g. balance confidence, physiological balance, pain and falls) but this has not yet been collectively tested in a sample of older adults with CMP.

10.5 Summary of chapter

The current chapter is the first large study to investigate differences in balance confidence in those with CMP compared to a group without CMP. Moreover, the study demonstrates that both pain severity and number of CMP sites are associated with lower balance confidence in a sample of community dwelling older adults. The associations between pain severity and multisite pain with balance confidence remained evident even after adjustment for several well established risk factors. There is a need for future prospective research to better understand these relationships and in particular to develop and test interventions to improve pain symptoms, balance confidence and mobility limitations in older adults with CMP. Given the results of the previous 4 chapters, which clearly demonstrate marked deficits in mobility limitations and fall related factors, there is a need to consider the wider impact of these on HRQOL in the sample. Therefore, the fifth quantitative results chapter will investigate the impact of the mobility limitations on wider HRQOL in the sample.

CHAPTER 11

INVESTIGATING THE IMPACT OF MOBILITY LIMITATIONS AND FALL RELATED FACTORS ON THE HEALTH RELATED QUALITY OF LIFE OF OLDER ADULTS WITH CHRONIC MUSCULOSKELETAL PAIN

This chapter is based on the published paper:

Stubbs B, Schofield P, Patchay S. (2015) Mobility Limitations and Fall-Related Factors Contribute to the Reduced Health-Related Quality of Life in Older Adults With Chronic Musculoskeletal Pain. Pain Practice, In press.

This chapter relates to secondary aim 4.

Overview of the chapter

The previous four chapters established that older adults with CMP are more sedentary, more likely to experience falls and have reduced balance confidence. In addition, the third results chapter found that pain interference is independently associated with each of the four psychological concerns related to falls. Given the marked influence of musculoskeletal pain characteristics on these mobility limitations and fall related factors, there is a need to consider how these relate to HRQOL and important patient reported outcome measures. Previous literature has established that older adults with CMP experience a reduced HRQOL, but the impact of these heightened mobility limitations and falls risk factors had never been investigated previously. The current chapter meets this gap and established that collectively these factors are significantly associated with lower HRQOL in older adults with CMP. Thus, this chapter is the first research to demonstrate the wider impact of these factors on HRQOL in this population.

11.1 Introduction

Previous research has demonstrated that musculoskeletal pain is associated with disability (21), mobility limitations (25, 278) and functional decline (245) in older adults. In addition, CMP is related to an increased risk of falls (230, 249), lower levels of physical activity (137) and also fractures (98). More specifically, the previous results chapters found that CMP is associated with sedentary behaviour (chapter 7), falls (chapter 8), psychological concerns related to falls (chapter 9) and in particular reduced balance confidence (Chapter 10). Such mobility difficulties are pertinent, since each of these are in the general older adult population associated with a diverse range of deleterious outcomes. In light of these factors it is not surprising that older adults with CMP often experience a reduction in their HRQOL (98). However, to the best of the researcher's knowledge, no author has previously investigated the impact of mobility limitations and fall related factors on the HRQOL of older adults with CMP.

HRQOL is an important patient reported outcome (PRO) and is a measure of the impact an illness has upon the functional health status as perceived by the patients themselves (279, 280). In addition, HRQOL is an important outcome among policy makers, researchers and clinicians (281). Indeed, in response to the increasing age of the general population, a number of policies have been developed to specifically promote HRQOL in older age (282, 283). A range of HRQOL measures currently exist, but one measure, the European Quality of life instrument (EQ-5D-5L (217)) is commonly used in clinical practice and research(284). The EQ-5D 5L asks the participant to rate their overall perceived health state from 0 (worst imaginable health state possible) to 100 (best imaginable health state possible) and this provides a summary of their HRQOL (284). The EQ-5D 5L is advocated as a measure to ascertain HRQOL in older adults in international guidelines (56). For the purposes of this

study, HRQOL was defined as the summary score from the EQ-5D 5L (i.e. their own rating of their overall health state).

Despite the aforementioned reasons for concern, research investigating the contribution of mobility limitations, falls and psychological concerns related to falls to HRQOL in older adults with CMP is sparse. Identifying determinants for HRQOL is important so that clinicians can seek to develop appropriate interventions. From a clinical perspective, it seems plausible that experiencing mobility limitations (e.g. difficulty with balance), having a heightened risk of falls and more sedentary behaviour (sitting for longer) could contribute to a reduced HRQOL. If this is true, then from a theoretical perspective, it seems that these mobility factors could impact the two key domains of current HRQOL identified by the International Classification of Functioning, Disability and Health (ICF (285)). First, mobility difficulties if present are key body tasks that may influence the older adults functioning (286). Second, mobility limitations and increased falls risk have the potential to affect the individual's participation in wider society(286).

With the global demographic changes and high numbers of older adults affected by CMP (13, 287), it is essential that research is conducted to investigate the impact of CMP on HRQOL in community dwelling older adults. The purpose of the current study was to investigate the impact of CMP on HRQOL and in particular the contribution of mobility limitations and falls related factors.

It was hypothesised that mobility limitations (reduced lower limb function, sedentary behaviour) and fall related factors (including falls history and psychological concerns related to falls) would significantly contribute to a reduced HRQOL in older adults with CMP.

11.2 Method

Study design and Participants

A multisite cross sectional study was conducted in the UK in 2013 across 10 participating centres. Full details of the recruitment, eligibility criteria and protocol are in the research methods chapter.

Demographic and medical information

For the current study, background information including age (years), gender and living arrangements (living warden accommodation yes/ no) were ascertained. In addition, the mean number of self-report physician diagnosed comorbidities and medications taken over the past two weeks were calculated. Participants were also asked if they wore glasses or currently smoked (yes/no).

Chronic musculoskeletal pain

All participants were assessed for CMP in according to previous research (11, 216) and in line with recognised pain assessment guidelines (13, 212) as outlined in the research methods chapter. In addition the duration of pain was ascertained in years and months. Moreover, all participants completed the BPI and the mean scores across the severity and interference subscales were calculated to give an overall score of pain severity and interference respectively (216).

Health related quality of life

All participants completed the European Quality of Life Instrument (EQ-5D-5L (217)). Within the EQ-5D-5L, participants rated their perceived overall health state from 0 (worst imaginable health state) to 100 (best imaginable health state). The mean overall health state was the primary outcome measure in this study (HRQOL). The EQ-5D-5L is easy to use and

a practical tool to capture HRQOL in older age and the European falls network, PROFANE, recommend the EQ-5D-5L to measure HRQOL (56). In addition, the EQ-5D-5L has recently been used in research investigating physical performance and mobility limitations among community dwelling older adults (219).

Mobility assessment

In order to assess functional mobility, all participants completed the TUG test (220). The TUG requires participants to stand up from a chair, walk 3 meters, turn around, walk back and sit down again. The time taken was measured in seconds and scores represent functional mobility with higher scores indicating increasing mobility difficulties (25). Participants who scored >13.5 seconds were classified as having mobility limitations (25). Details of participants walking aid use was also collated (yes/ no).

Sedentary Behaviour

Higher levels of sedentary behaviour are associated with lower HRQOL in general community dwelling older adult settings (78). Sedentary behaviour was assessed using the sedentary behaviour specific questions of the IPAQ-SF (223). The questions enquire about the amount of time spent sitting per day over the previous week (hours and minutes per day). Participants were provided with examples of sitting behaviour such as sitting at home (e.g., watching television, reading), at work (sitting at a desk) and during leisure time (e.g., visiting a friend) to aid their answer. The IPAQ SF is a valid and useful tool to assess both physical activity and sedentary behaviour in older adults (243).

Psychological concerns related to falls measures

All participants completed the activities and balance confidence scale (ABC, (114)). In addition, all participants completed the COF (49). Previous research (44) within the general older adult population has established that the ABC and COF are important determinants of HRQOL. Therefore, the current study investigated the influence of these on HRQOL.

Data analysis

All data analysis was conducted using SPSS (version 20). Continuous data were assessed for normality with a visual inspection of PP plots and the calculation of skew and kurtosis to ensure normal ranges (244). Independent t tests and chi squared tests were used to compare the continuous and categorical variables respectively between those with and without CMP. When tests for normality and equality of variance were not satisfied, non-parametric equivalents were employed. The relationship between HRQOL (dependent variable) and demographic, medical, pain, mobility and fall relate factors were assessed with Pearson's product moment correlation coefficient (Pearson's r). Next a hierarchical a multiple regression was conducted with the mean HRQOL score as the dependent variable and independent variables being inserted into the model in two steps. Within the first step of the model, the following independent variables were inserted demographic (mean age, gender), medical factors (mean number of comorbidities, mean number of medications) and pain factors (duration of pain (years), mean BPI interference subscale) into the model. Next, the mobility (walking aid use, TUG scores, sedentary behaviour) and falls related factor independent variables (history of falls, COF and ABC scale) were inserted into the model. Changes in adjusted R^2 were noted in order to investigate their unique contribution on the variance of the HRQOL (244). At each step of the model, the standardised beta-coefficients were reported to see the unique contribution of each independent variable in the fully

adjusted model. Multicollinearity was assessed by calculation of the VIF and tolerance for each model ensuring this was within satisfactory ranges (VIF <10 and not much higher than 1; and tolerance > 0.2;(244)). All analysis conducted was two tailed and significance was set at $p < 0.05$.

Sample size calculation

An a-priori sample size calculation was conducted using G power software for the regression analyses. Based upon on an R^2 increase with 12 predictors in the model, a power of 0.8, significance level at 0.05 and a medium effect size ($F^2=0.15$) a total sample size of 127 was required in the CMP group. Therefore, the current study was adequately powered.

11.3 Results

Participant characteristics

In total, 295 older adults out of a possible 401 had valid data for the current study (response rate 73.5%). The mean age of the 295 participants was 77.5 years (± 8.1 years), 196 were female (66.4%) and 268 were Caucasian (90.8%).

Prevalence and impact of chronic musculoskeletal pain

Overall, 154 participants (52.2%) met the criteria for CMP and 141 (47.8%) did not and formed the comparison group. Of those with CMP, almost two thirds (90/ 154, 58.4%) had pain across multiple sites. The most common primary sites of pain were the knee (n=64/154, 41.6%), back (n=36/154, 23.4%) or foot (n=18/154, 11.7%).

There was no statistically significant difference in the mean age or proportion of females in the CMP group and the comparison group (table 11.1). However, the CMP group had a higher number of co-morbidities and took more medications. Lastly, older adults with CMP reported a significantly lower perceived overall HRQOL compared to the comparison group. Full details are summarised in table 11.1.

Table 11.1 Comparison of demographic and medical factors and quality of life of the group with chronic musculoskeletal pain and the comparison group

Variable	Comparison group (n=141)	Chronic musculoskeletal pain (n=154)	P value
<i>Age (years, SD)</i>	76.6 (\pm 8.5)	78.3 (\pm 7.8)	.08
<i>Female n (%)</i>	95 (67.4)	101 (65.6)	.80
<i>Live in warden accommodation n (%)</i>	42 (29.8)	72 (46.8)	<.001
<i>Current smoker yes (%)</i>	11 (7.8)	15 (9.7)	.30
<i>Wear glasses yes (%)</i>	77 (54.6)	105 (68.2)	.22
<i>Number of comorbidities (SD)</i>	2.8 (\pm 1.3)	3.9 (\pm 1.2)	<.001
<i>Number of medications (SD)</i>	2.9 (\pm 2)	3.6 (\pm 2)	<.001
<i>Health related quality of life</i>			
<i>How good or bad is your health? (0-100, SD)</i>	79.8 (\pm 15.6)	58.3 (\pm 20.6)	<.001
<i>Chronic Pain classification</i>			
<i>Duration years median(range)</i>		3 (0.4-50)	
<i>Single site n (%)</i>		64 (41.6)	
<i>Multisite n (%)</i>		90 (58.4)	
<i>BPI severity (SD)</i>		5.6 (\pm 1.8)	
<i>BPI interference (SD)</i>		4.8 (\pm 2.0)	

Key for **table 11.1**: BPI severity = brief Pain inventory pain severity subscale, BPI interference = brief Pain inventory pain interference subscale, SD= standard deviation

As can be seen from table 11.2, the CMP group experienced pronounced mobility limitations and increased falls risk factors (all $p < 0.001$). For instance, those with CMP were significantly more likely to use a walking aid, were more sedentary and more likely to have experienced a fall in the previous 12 months. In addition, older adults with CMP experienced a substantially reduced balance confidence ($p < 0.001$) and had more concerns about the adverse consequences of falling over on the COF scale ($p < 0.001$).

Table 11.2 – Comparing the mobility and fall related factors between the chronic musculoskeletal pain and comparison group

Variable	Comparison group (n=141)	Chronic musculoskeletal pain (n=154)	P value
<i>Walking Aid use yes (%)</i>	37 (26.2%)	97 (62.9%)	<.001
<i>In the past year have you had a fall? Yes (%)</i>	48 (34%)	91 (59%)	<.001
<i>Sedentary behaviour (hours per day, SD)</i>	7.9 (± 3.7)	11.0 (± 3.36)	<.001
<i>Timed get up and go scores (sec, SD)</i>	10.9 (± 4.5)	14.6 (± 4.6)	<.001
<i>Timed up and go >13.5sec (%)</i>	26 (18.4)	72 (47.1)	<.001
<i>Balance confidence (Total ABC, %)</i>	71.3 (± 22)	48.3 (± 20.7)	<.001
<i>COF scale (SD)</i>	25.7 \pm 5.9	31.8 \pm 5.3	<.001

Key for table 11.2= ABC= activities balance confidence scale, COF= consequences of falling scale.

Table 11.3 demonstrates that the demographic and medical factors were not significantly related to HRQOL in the older adults with CMP. However, significant negative correlations were identified with sedentary behaviour, timed up and go scores, pain severity, pain interference and COF scale scores in the sample with CMP. Only higher balance confidence was positively associated with HRQOL in the sample with CMP (table 11.3).

Table 11.3 Pearson correlation coefficients of HRQOL with demographic, medical, mobility and falls related factors and pain variables in 154 older adults with chronic musculoskeletal pain

Variable	Pearson r	P value
<i>Age (years)</i>	.04	.58
<i>Female n (%)</i>	-.03	.68
<i>Number of comorbidities</i>	-.08	.31
<i>Number of medications</i>	-.10	.18
<i>Walking Aid use (%)</i>	-.17	.02
<i>History of falls (%)</i>	-.13	.10
<i>Sedentary behaviour (IPAQ-SF)</i>	-.31	<.001
<i>Timed get up and go scores (sec)</i>	-.26	<.001
<i>BPI Pain severity</i>	-.32	<.001
<i>BPI Pain interference</i>	-.29	<.001
<i>Balance confidence (ABC scale)</i>	.28	<.001
<i>Concerns about the consequences of falling (COF scale)</i>	-.40	<.001

Key for table 11.3= ABC= activities balance confidence scale, COF= consequences of falling scale, IPAQ-SF – international physical activity questionnaire, short form, BPI severity = brief Pain inventory pain severity subscale, BPI interference = brief Pain inventory pain interference subscale

The background demographic and medical factors explained 14% of the variance observed within the HRQOL scores ($F_{[6,138]}=3.73$, $p=0.02$, $R^2=0.14$, adjusted $R^2=0.102$). In the first step of the model, only the mean BPI interference subscale score was an independent predictor of HRQOL ($\beta=-.368$, $p<.0001$). The introduction of the mobility and falls risk factors at the second step significantly increased the variance explained within HRQOL scores from 14% to 36.4% with an adjusted R^2 change of 20.4% ($F_{[6,132]}= 7.78$, $p<.0001$, adjusted $R^2=.306$). Within the fully adjusted model, the largest significant unique predictors in HRQOL scores were sedentary behaviour ($\beta=-.366$, $p<.0001$), pain interference ($\beta=-.353$, $p<.0001$), concerns about the consequences of falling scale scores ($\beta=-.330$, $p<.0001$), history of falls ($\beta=-.285$, $p<.0001$), timed up and go scores ($\beta=-.271$, $p=.005$) and balance confidence ($\beta=.296$, $p=.01$). A summary of the hierarchical regression model is presented in table 11.4.

Table 11.4 – Summary of hierarchical multiple regression analysis investigating the predictors of health related quality of life (dependent variable) in older adults with chronic musculoskeletal pain (n=154)

Independent Variables	Step 1			Step 2		
	<i>B</i>	<i>SE B</i>	β	<i>B</i>	<i>SE B</i>	β
Constant	70.640	19.083		112.365	23.405	
Age	.086	.230	.031	.353	.220	.128
Gender	.064	3.517	.001	5.178	3.246	.119
Number of comorbidities	1.253	1.764	.072	2.761	1.603	.158
Number of medications	-.708	1.061	-.069	-1.093	.951	-.107
Duration of pain	.378	.220	.142	.366	.199	.138
Mean BPI interference score	-4.196	.992	-.368***	-4.031	1.046	-.353***
Walking aid use				6.643	4.078	.155
Sedentary behaviour				-.037	.011	-.366***
TUG score				-.941	.326	-.271**
History of falls				-6.99	1.920	-.285***
COF scale				-1.282	.381	-.330***
ABC scores				-.290	.122	.296*

Key for table 11.4: *= p<0.05, **= p<0.01, *** = p<0.001, B and SE (standard error) B= unstandardized coefficients, β = standardised beta coefficients. Independent variables entered into the model at step 1 = Age, gender, number of comorbidities, number of medications, duration of pain (mean years), mean BPI (brief pain inventory) interference score. Independent variables entered into the model at step 2: = All the variables at step 1 and walk aid use, sedentary behaviour, TUG score (timed up and go), history of falls in past 12 months, COF scale (consequences of falling scale), ABC (activities balance confidence scale). HRQOL=dependent variable.

11.4 Discussion

To the researcher's knowledge, the results from the current chapter are the first to demonstrate that increased mobility limitations and falls related factors are associated with a reduced HRQOL in older adults with CMP. The final quantitative study builds on the previous four quantitative result chapters to demonstrate the wider deleterious impact of the mobility limitations and fall risk factors on HRQOL in older adults with CMP. Specifically the study demonstrated that not only pain interference but also sedentary behaviour, mobility limitations (measured by timed up and go scores), a history of falls and increased concerns about the consequences of falling were all significant negative predictors of HRQOL. Of particular interest the study also found that that better balance confidence was positively associated with improved HRQOL which may have important implications for clinicians.

The present study also demonstrates that older adults with CMP had a significantly lower HRQOL compared to a group of similar age and gender without CMP. Despite the relative paucity of research specifically investigating HRQOL and its determinants in community dwelling older adults with CMP, this is not surprising since musculoskeletal pain is known to have a substantial impact on older adults (15). In fact, the current study established that the CMP group had significantly more mobility limitations, spent more time being sedentary, had more psychological concerns related to falls and actual falls than the comparison group. This is similar with earlier work which has also highlighted such profound mobility deficits in those with CMP. For instance, Karttunen et al (25) reported that older adults with musculoskeletal pain were significantly more likely to report mobility limitations according to the TUG. This finding was exemplified by Pereira et al (260) who found older adults with chronic pain had significantly poorer physical performance. Recently in a large nationally representative sample, Patel et al (15) reported that those with multisite pain are at greatest risk of experiencing mobility limitations such as a slower gait speed. The authors found that

up to 80% experienced difficulties undertaking fundamental ADL. Eggermont et al (24) found that pain interference measured by the BPI interference subscale is a predictor of mobility limitations and onset of difficulties in ADL. Earlier work has also established that musculoskeletal pain may be predictive of functional decline and disability (245) and possibly an early marker for frailty syndrome (98). With this mounting evidence, that CMP and pain interference causes mobility limitations, it seems important to identify those with CMP and offer appropriate interventions (15).

A central aim of this chapter was to investigate the factors associated with HRQOL and in particular the influence of mobility and falls related factors since to the researcher's knowledge no previous study had investigated the latter. Within the hierarchical regression analysis, it was demonstrated that mobility and falls related variables resulted in a statistically significant increase in the variation explained with the HRQOL scores in this sample of older adults with CMP. Within the fully adjusted model when all other variables were controlled for, sedentary behaviour remained the largest independent predictor of HRQOL. This is perhaps unsurprising, since previous longitudinal research by Balboa-Castillo et al (78) has demonstrated in the general population that lower levels of sedentary behaviour are associated with better HRQOL. In addition, Denkinger et al (288) found that physical inactivity is associated with increased healthcare utilisation. However, it should also be of concern since a recent large prospective study demonstrated that physical inactivity is associated with an increased risk of developing disability (289). This particular finding adds to pressing calls to reduce sedentary behaviour and increase physical activity within the general population (76). This is particularly important since the World Health Organisation (33) recently confirmed that physical inactivity is the 4th leading cause of avoidable death across the world. Moreover, the first results chapter demonstrated that the older adults with CMP spent approximately 3.5 hours more a day being sedentary than the comparison group.

Thus, the current chapter builds on the wider impacts of this behaviour. However, this is counterintuitive as physical activity is known to prevent the onset of disability and difficulties undertaking ADL (82, 289) and is also effective in relieving pain and disability (39) and falls (168). Therefore, it would seem important that physical activity is promoted in this group. This is particularly when physical activity is known to have a beneficial impact on older adults mental health (29), is associated with lower healthcare utilisation and better HRQOL in the general older adult population (78, 288). Current guidelines recommend the promotion of physical activity to manage CMP (13) and most countries across the world have targets for physical activity in response to the wider benefits it has upon health and wellbeing (290).

Of less surprise is the finding that higher pain interference was the second largest independent predictor of HRQOL in the current sample. Previous work (24) has established pain interference is a stronger predictor of mobility and ADL limitations than pain severity. Moreover, the third results chapter (chapter 9) (291) also demonstrated pain interference is strongly associated with increased psychological concerns related to falls. It is however, interesting to note that the duration of pain was not a predictor of HRQOL in the current sample, thus suggesting that pain that causes interference with ADL over the past two weeks may be a more important determinant. Next to the aforementioned, mobility limitations (timed up and go scores), a history of falls and increased concerns about the consequences of falling over were significantly associated with HRQOL in the sample with CMP.

Clinical implications

As a first step, clinicians should seek to correctly identify those with CMP and treatment should be offered in line with pain assessment guidelines. For example, the British Geriatrics and British Pain Society (13) state that pharmacological interventions such as paracetamol can be considered. However, the potential role of physical activity and structured exercise

should be considered by clinicians as an essential non-pharmacological approach since it can improve pain symptoms, reduce disability (39), preventing difficulties undertaking ADL (82) and improve HRQOL (78). Physical activity is also effective in preventing falls (168), particularly those that cause injuries (169) and improving mobility limitations. Moreover the meta-analyses within the literature review chapter consistently found that older adults with pain are at increased risk of falls and physical activity may play an important role in falls prevention (59). When one considers the aforementioned and that the benefits of physical activity are comparable to pharmacological interventions in reducing mortality (247) it seems that physical activity has a pertinent role. However, at this stage much of this is speculation, drawing upon research findings investigating individual facets that it has been found were associated with HRQOL in older adults with CMP. Thus, it is not possible to make specific recommendations regarding the frequency, intensity and type of physical activity to improve HRQOL, pain and mobility related factors beyond that given in the general population or in recognised pain assessment guidelines (13). Therefore, future research should investigate the possibility of physical activity to prevent falls, improve mobility, reduce pain/ disability and also consider its impact on HRQOL.

Strengths

A specific strength of this study is that it was conducted across multiple sites and CMP was assessed according to recognised criteria. In addition, this was the first study investigating the influence of mobility limitations on HRQOL. The prevalence of CMP in the current study is in line with the literature (11, 216) and as outlined in detail in the research methods chapter and in the methods section above the current study used a range of robust measures to investigate mobility limitations (timed up and go), sedentary behaviour (IPAQ-SF), pain interference (BPI interference subscale) and balance confidence (ABC scale) and COF scale. In addition, the results were convincing, finding for the first time that mobility and falls risk

factors are pronounced in this group and are important determinants in HRQOL. However, caution should be given due to the cross sectional nature of the study and future prospective research is required to disentangle these relationships and importantly investigate the potential role of physical activity on HRQOL, pain, mobility limitations and falls risk. Moreover, as identified in the methodology chapter, there are limitations to findings derived purely from quantitative research. Therefore, qualitative research is now required to understand the perspective of individuals with CMP experience of each of the three phenomena of interest: physical activity/ sedentary behaviour, falls and psychological concerns related to falls. In addition, qualitative research will also enable exploration of the findings of the quantitative chapter results to date in more detail.

11.5 Summary of chapter

The final quantitative results chapter has attempted to collate the findings from the previous four quantitative chapters and assess the impact of mobility limitations and falls risk factors on HRQOL. More specifically, the chapter established that sedentary behaviour, mobility limitations (slow timed up and go), history of falls and psychological concerns related to falls (increased concerns about the consequences of falling and balance confidence) are independently associated with lower self-perceived health state in the CMP sample. Given the findings of the previous quantitative research chapters and limitations of these, the secondary qualitative research will now attempt to explore these phenomena in more detail in line with the mixed methods sequential explanatory model.

11.6 SUMMARY OF THE QUANTITATIVE RESEARCH CHAPTERS

The 5 quantitative results chapters have built on the 3 literature review chapters to address the 5 aims of the thesis (including all 3 primary aims and the 4th secondary aim). Specifically, the results chapters have established that older adults with CMP are significantly more sedentary than an age-matched group without CMP (primary aim 1). In addition, the second results chapter built on the gaps and limitations identified within the respective literature review chapter to conduct the first study to investigate clearly defined CMP and the relationship with recurrent falls. Specifically, the second results chapter identified for the first time that older adults with multisite CMP are at greatest risk of recurrent falls and also demonstrated that the BPI may prove a useful measure to identify those most at risk (primary research aim 3). The literature review chapter investigating pain and psychological concerns related to falls identified limitations which the third results chapter sought to overcome. Specifically, the third results chapter established that pain interference is independently associated with each of the four common psychological concerns related to falls after the adjustment for previously established risk factors (primary aim 2). The fourth results chapter considered the influence of the number of musculoskeletal pain sites and of pain severity on balance confidence (primary research aim 2). Moreover, the fourth chapter found that both multisite pain and those categorised as having the highest pain severity had the lowest balance confidence. Finally, the fifth results chapter considered the impact of these identified mobility limitations and falls risk factors on the HRQOL of those with CMP. The results demonstrated that older adults with CMP experience a large and significantly decreased HRQOL and the mobility limitations and falls risk factors appear to contribute to this (Secondary aim 4).

Limitations from the quantitative results chapters

Whilst the results in the preceding chapters are novel, it is important that several limitations are considered when interpreting the results. First, although numerous attempts were made to ensure that no participants with cognitive impairment and/ or dementia were recruited, it is possible that some people with a degree of cognitive impairment entered the study. Second, the study was cross sectional and can only refer to association and not causation. In addition, the study was only conducted in one country and it remains unclear whether or not the results are generalisable to other countries. Third, the participants were self-selected and although the study was conducted across multiple sites it was not feasible to recruit a random sample. Fourth, all data were collected by the researcher and this may have introduced bias.

Nevertheless, allowing for these caveats, throughout the thesis so far, a clear progression can be seen from the systematic literature reviews up to the primary data papers in which all of the papers have been published in a prospective manner to ensure that the findings are disseminated to the public as soon as possible in line with good practice. Moreover, the thesis set out in this way to attempt to achieve among other things the following FHEQ criteria required to be awarded a PhD:

- The creation and interpretation of new knowledge, through original research or other advanced scholarship, of a quality to satisfy peer review, extend the forefront of the discipline, and merit publication
- A systematic acquisition and understanding of a substantial body of knowledge which is at the forefront of an academic discipline or area of professional practice.
- The general ability to conceptualise, design and implement a project for the generation of new knowledge, applications or understanding at the forefront of the discipline, and to adjust.

- A detailed understanding of applicable techniques for research and advanced academic enquiry.

Given the prospective acquisition and interpretation of new knowledge, it is the intention now to conduct the second phase of the sequential explanatory model and investigate the experiences of a convenience sample of older adults with CMP of falls, psychological concerns related to falls and physical activity (secondary aim 5).

CHAPTER 12

A QUALITATIVE STUDY INVESTIGATING OLDER ADULTS EXPERIENCES OF FALLS, PSYCHOLOGICAL CONCERNS RELATED TO FALLING AND PHYSICAL ACTIVITY

This chapter is based on a paper submitted to Disability and Rehabilitation.

This chapter relates to secondary aim 5.

Overview of the chapter

The current qualitative chapter forms the second part of the mixed methods sequential explanatory model for the PhD thesis. More specifically, the current chapter recruited a convenience sample of older adults with CMP that participated in the quantitative phase to explore their experiences of the three main phenomena of the PhD 1) psychological concerns related to falls, 2) falls and 3) physical activity/ sedentary behaviour. Four key themes emerged: i) psychological concerns related to falling ii) the experience of falls iii) the importance of staying active and iv) emotional burden. The results established that both fallers (n=10) and non-fallers (n=10) experienced psychological concerns related to falls, including FOF and said they avoided more activities due to both their pain and also FOF. Participants recognised that their pain increased their falls risk, but often attributed previous falls to external factors (e.g. trips) and rationalised falls. Participants valued physical activity and often had to make adaptations to remain active which was motivated largely to prevent a loss of independence. Given that few participants directly attributed pain as the sole cause of falls, this suggests that despite the strong quantitative evidence confirming a link, the relationship between pain and falls may be more complex than previously thought. However, given the lack of generalisability of the sample, it is unclear if the results extend beyond the current sample. Moreover, this illustrates the benefits of adopting a mixed methods pragmatic approach and using the benefits and limitations of each other to provide a more complete picture of the topics within the thesis.

12.1 Introduction

Recently a number of population based studies have demonstrated that musculoskeletal pain can have a range of adverse outcomes related to mobility. For instance, data from the MOBILIZE Boston study established that CMP is associated with falls (11) and lower levels of physical activity (240). In addition, a previous study (240) demonstrated that CMP is associated with higher levels of sedentary behaviour. Two analyses from a nationally representative sample in the United States have demonstrated that an increasing number of pain sites is associated with an increasing decline in physical function (15) and higher levels of FOF (60).

Building on this, the literature review chapters within the thesis established the relationship between CMP and physical activity (chapter 2) (137), psychological concerns related to falls (chapter 3) (225) and falls (chapter 4) (230, 249). The systematic review chapters enabled the appraisal of the literature to date and were the basis for the development of the previous 5 previous quantitative chapters. Specifically the previous results chapters found a relationship between CMP and sedentary behaviour (chapter 7), recurrent falls (chapter 8), psychological concerns related to falls (chapters 9 and 10) and in turn identified how this had a deleterious impact on HRQL (chapter 11). Whilst this quantitative research has been unequivocal in highlighting the impact of CMP on mobility outcomes, qualitative research is required to better understand the experiences of CMP of these mobility outcomes from the perspective of the individual. Qualitative research supports a deeper understanding of a particular problem from the perspective of the individual and goes beyond the confines of understanding a phenomenon through a narrow lens such as a quantitative outcome measure. Qualitative research on the other hand focuses on subjective meaning and seeks to explain people and their behaviour in great depth through a narrow lens whilst obtaining context (178).

Conducting such research is essential in order to understand complex phenomena and subsequently develop interventions that are acceptable in the real world setting.

To date, there is a relative paucity of qualitative research investigating the experiences of older adults with CMP regarding mobility limitations such as physical activity/ sedentary behaviour, psychological concerns related to falls (e.g. FOF or balance confidence) and actual falls. Most qualitative research to date has considered the beliefs and experiences of older adults with CMP towards their pain and interactions with healthcare professionals (74, 292, 293). One recent study (294) explored physical activity in older adults with CMP. The authors established that older adults with CMP often impose activity restriction due to their pain, thus predisposing themselves to social isolation and deconditioning. The authors established that the reduction in physical activity levels and avoidance were rationalised as being normal for their age and often co-existed with a sense of determination and frustration from these limitations. Another study (295) found that older adults with CMP often slowdown in their activities but still strive to be active due to fear they will lose their independence and strive to maintain their quality of life. Such qualitative studies have provided a unique insight into the challenges that are encountered by people with CMP which cannot be clearly elucidated or put into context from quantitative research. To the best of the researcher's knowledge, qualitative research investigating other mobility difficulties in older adults with CMP such as psychological concerns related to falls and actual falls is absent. Such research is important to elaborate the recent quantitative research that has consistently demonstrated increased risk in those with CMP including the systematic reviews and quantitative research papers to date (11, 15, 60, 225, 291, 296).

The purpose of the present study was to investigate the experiences of a convenience sample of older adults with CMP towards physical activity, sedentary behaviour, psychological concerns related to falls and actual falls.

12.2 Method

Design

This study forms the qualitative arm of the PhD investigating the impact of CMP on physical activity, falls and psychological concerns related to falls in community dwelling older adults. Full details of the qualitative research philosophy, methods, recruitment and procedures are presented in the research methods chapter (chapter 6).

Participants and Recruitment

In brief, a convenience sample with CMP was recruited and included 8 individual semi structured interviews and a focus group (N=12). The potential participants were identified from two centres in London where data were collected for the quantitative phase of the project (See research methods chapter for details). The focus group took place in a sheltered housing scheme for community dwelling older adults whilst the individual interviews were conducted in a day centre for older adults, where they attended on set days for activities. The eligibility criteria were the same as the quantitative phase, but only those who had complete data for the quantitative phase were approached to take part.

Data Collection

The interview schedule focussed on the participants experiences of 3 key areas relating to mobility difficulties namely 1) physical activity/ sedentary behaviour, 2) psychological concerns related to falls and 3) falls. The interview schedule's three areas were developed with reference to the literature (137, 225, 230) and also from the findings of the quantitative results from the thesis. Semi structured interviews were specifically sought since they consist of open ended questions on particular topics and are ideal to elicit detail accounts of individuals experiences of a particular phenomenon (228, 231). All interviews were

conducted by the researcher in a quiet location and digitally recorded. The individual interviews lasted approximately between 15 and 25 minutes (mean 20) and the focus group lasted 86 minutes. The same interview schedule was utilised in both the individual interviews and the focus group. Qualitative interviews were undertaken until the point of saturation (186).

Data analysis

Full details of the qualitative analysis are given in the research methods chapter. In brief, following transcription of the interviews, an inductive thematic analysis was undertaken by the researcher involving two other researchers following the method described by Pope and Mays (186). The thematic analysis was undertaken manually without any specialist software.

12.3 Results

Participant demographics

Twenty older adults with CMP took part in the study (N=12 in the focus group and N=8 individual interviews). Only one participant that was approached declined to take part (they did not have time in their schedule). Among the focus group participants, 8 were females and 4 were males and their age ranged from 63 to 87 years. Five females and 3 males with an age range from 70 to 88 years took part in the individual interviews. The duration of CMP ranged from 3 months to 8 years. Overall, 13 of the group had CMP across multiple sites (2> locations) and 7 had single site CMP. Regarding mobility, 10 of the sample had a history of falls and 12 currently used a walking aid. Further details of the key participant demographics are summarised in table 12.1.

Table 12.1 – Summary of participant characterises

Participant number	Sex	Age (years)	Duration of CMP (years)	Single of multisite CMP	Self-report physician diagnoses	Use a walking aid	History of falls (Classification of falls)
Individual interviews							
1	F	80	1	M	OA, LLP	Y	Y (S)
2	F	82	1.4	M	CLBP	Y	Y (S)
3	F	88	1.4	M	NP, LLP	Y	N
4	F	81	0.5	S	OA	Y	N
5	M	72	1	S	CLBP		N
6	M	70	5	M	OA, CLBP		Y (S)
7	M	82	0.4	S	OA	Y	Y (R)
8	F	79	4	M	ULP, NP	Y	N
Focus Group							
9	M	87	1.4	M	OA	Y	Y (S)
10	M	69	1.5	M	NP		N
11	M	71	6	M	OA, LLP		N
12	M	75	4	M	OA, CLBP, NP		Y (R)
13	F	72	2	S	OA		Y (S)
14	F	71	0.4	S	OA		N
15	F	81	1	S	OA	Y	Y (R)
16	F	66	1	M	OA, ULP		N
17	F	63	0.9	M	CLBP, LLP		N
18	F	72	0.9	S	OA	Y	N
19	F	73	8	M	LLP	Y	Y (S)
20	F	70	3	M	ULP, NP	Y	Y (R)

Key for table 12.1= M=multisite pain, S= single site pain, Y=yes, N=no, F=female, M=male, OA= osteoarthritis, CLBP= chronic low back pain, SST=spinal stenosis, NP= neck pain, ULP=upper limb pain, LLP=lower limb pain, Classification of falls S=single fall and R=recurrent fall (those that falls two or more times).

Responses to the closed questions regarding the impact of their CMP

Overall, 50% (6/12) in the focus group believed that since having their CMP they sat down more as a result. In addition, 50% (6/12) believed they are more fearful of falling whilst 41.6% (5/12) said they think they are more likely to fall over because of their pain. Almost all (91.6%, 11/12) responded to say that they enjoyed life less as a result of their pain, but all (100%, 12/12) agreed with the belief their pain was a natural part of the aging process. Three

quarters of participants believed that medication helped their pain (75%, 9/12) and all (100%, 12/12) stated that physical activity helped their pain.

Thematic analysis

Four different themes emerged from the analysis including: i) Psychological concerns related to falling ii) the experience of falls iii) the importance of staying active, iv) emotional burden. A summary of the themes, subsequent subthemes and an illustrative quote is displayed in table 12.2.

Psychological concerns related to falling

Subtheme – Fear of falling and adaptations

It was evident that both participants with and without a history of falls experienced FOF. However the effect of FOF among those that had fallen was particularly marked. For example, a quote from a participant who recently fell highlights the pervasive nature of FOF *‘I am constantly worried about falling over....I am just frightened, when you have had a fall and experienced that you never want to go through it again’* (Female, participant (P) 1). Nevertheless, some participants described their FOF as rational and believed that other factors beyond their pain also contributed as one male participant (male, focus group (FG) 12) describes *‘I worry more about falling than I used to as I have vertigo and it affects me and I am very careful because I don’t want to fall. The fear is quite real actually’*.

The FOF meant participants had to make adaptations in everyday activities and often involved the individual taking their time and being extra ‘careful’ undertaking their ADL. One participant stated (female, P3) *‘I have to be careful if I am going to bend over as I feel I am going to fall over’*. A female participant described in detail her experiences and coping strategy for FOF in the focus group *‘when I walk and come out at the garden I get ‘set’ and*

can't move and I get a feeling I am going to fall and I have to hold onto him (husband) in case I fall, and I am frightened to put one foot forwards in case I go down. It is frightening.' (Female, FG 15). For others, whilst their FOF was clearly present, there was an 'air' of defiance and determination to keep going among the participants. This is exemplified by one female participant who said *'I generally take it slowly now since I had the fall and I am much more careful, particularly around the stairs and I won't let it defeat me as I am a fighter'* (female, P2).

The use of walking aids was identified as important to improve confidence, reduce FOF and also help manage pain. For instance one stated *'I have a stick when I go out as I am concerned about falling. Sometimes I can't walk straight because of the pain, you know and the stick helps me straighten out'* (female, FG 15). There was however, a minority who stated they did not experience FOF, although this was largely confined to those that did not have a history of falling. For instance, one male in the focus group said *'I don't worry about falling as I am always one of those people who watches where I am going, I think they think I am looking for money on the floor'* (Male FG 10).

Subtheme – avoiding activities due to pain and FOF

Participants reported that they avoided more activities including ADL due to both their pain and because of FOF. For instance, one stated *'I avoid more activities now because if I move too much I am in so much pain. I am fearful of falling, but it's the pain that stops me getting so far (female, P3)*. However, for others it was the FOF more than the pain that resulted in more avoidance as one participant describes (Male, P5) *'I avoid more activities now because I am worried about falling and not because of pain.'* This was particularly noticeable in those that had fallen. For instance, one participant (female, P7) stated *'After I had those two falls it made me more careful and aware and not try to do too much at once'*. Moreover, for

other participants it appeared that pain and FOF were equal contributors to the avoidance of activities and these were inextricably linked. For instance, one stated '*when my pain gets bad I worry more about falling over and I suppose they (the pain and FOF) both make me worry and stop doing things around the house (ADL)*' (female, FG 19).

Sub theme – Balance confidence

Several participants were able to identify that their CMP had a marked effect on their balance confidence and this was again often tied in closely with increased FOF. For instance, one remarked '*My confidence in my balance is very unsteady, I won't move at times when my pain is bad because I am frightened I am going to fall* (Female, P1). There was also clear evidence that some people that had not fallen also had reduced balance confidence. One participant in the focus group described this and how they were able to overcome it: '*I have not fallen yet, but my confidence is affected when I get the pain as when the pain comes I panic. But you just have to wait until the pain passes, I sit down and stop and wait for it to pass or if I am up lean on something or stand still till it goes and start again but you do lose your confidence*' (Female, FG P16).

The experience of falls

Sub theme: feeling stupid and attributing falls to external factors

Some of the older adults described how they felt 'stupid' or embarrassed following a fall. For instance, one female participant in the focus group stated that '*I had a fall out in the street, but that was only by tripping up and over the paving stones as I was walking along and as I am a tall lady it's a long way to go. I broke my arm and I felt such a fool... I felt stupid.*' (Female, FG P19). Another stated '*I had a fall when I was out on a rotten slippery*

day, I lost my footing and fell but it was my own stupid fault for going out in it (the weather)
(Male, P6).

Participants frequently attributed their falls as a result of an external factor as opposed to internal falls risk factors. Moreover, falls were often seen as accidents as one female in the focus group said *'I had a fall, I was pushing my great grandchild in the swing and as I turned around I caught my foot and went bang on the floor'* (female, FG 20). Another male in the focus group described the circumstances to their fall *'I had a fall and came outside the gates, it was snowing and slippery. I was crossing the road and someone called me, I put my foot down and did not see a hole and tripped and fell'* (Male, FG9).

Sub theme: the impact of pain on falls

Few participants directly attributed their falls to their CMP, however most participants agreed that it increased their risk of falls. One female participant stated that having pain make you more likely to fall because *'it makes you worry more and less steady on your feet'* (female, FG 19). Another participant stated they believe that pain makes you more likely to fall because *'if you have pain in your hips or knee its part of the movement when you walk and it makes stepping trickier. It also must affect your balance.'* (Male, FG 9). It appeared that participants had many other comorbidities present and this was a factor why they were unable to clearly identify pain as the primary cause of falls. For example, one participant stated *'I think the pain does make you more likely to fall, but I have so many other things wrong with me I can't say how important it (the pain) is'* (Female, FG 20).

The importance of staying active

Subtheme 1 Balancing physical activity and sitting

Overall, participants felt that engaging in physical activity was an important strategy to manage their CMP. For instance, one participant stated '*Getting up and moving helps my pain; I just keep getting up and moving*' (Male, FG 9). Other participants stressed it was important to not sit for too long '*the pain gets worse when I sit too long, it's much better to keep moving and not getting stuck so I keep walking as I feel better when I am moving about and it diverts my thoughts away from the pain.*' (Female, FG 15). Difficulties getting going again after sitting for too long were common, for example '*When you go to get up if you have sat for too long your legs won't move.*' (Female, P4).

However, many participants reasoned there is a need to sit and rest for short periods which allowed their pain to subside. Individuals would combine periods of rest with periods of physical activity (rest-activity cycle) as a way to moderate their pain. For instance, one female participant in the focus group stated '*You can sit for a while ...it does relax you and the tension goes but then it's good to get up and move around again.* (Female, FG 15)' The participants generally agreed that a careful 'balance' must to be struck as sitting for too long can create difficulties 'getting going' again. One male participant revealed that whilst sitting can in the short term relief pain, getting back up proves difficult due to the pain and stiffness when they get back up. '*It relieves the pain somewhat (sitting)..... The pain goes a bit, it's not so much but when I try and get up it's so bad I wonder if it was worth the relief in the first place cause it's so bad when I get up.*' (Male, P6).

Sub theme – The importance of keeping active and overcoming difficulties with ADL

Many of the participants had to adapt their ADL due to their pain and this often meant activities took longer but maintaining their independence was clearly of utmost importance. For instance, one participant remarked that due to their pain *‘Everything takes longer now, I have to go at my pace and take my time’* (male, FG 10). Others made simple changes, which often included taking their time to enable them to be active and continue with their ADL. For instance one participant said *‘I still carry on and do the house work I am determined I am not going to let it (the pain) overtake me. I just keep doing things gently and at my pace and don’t do things madly’* (Female, P8). Participants were often motivated by the threat of inactivity to their independence in the long term. One participant was adamant that they *‘kept going’* as they did not want to end up in a wheel chair: *‘well I am trying to keep out of the wheel chairI am not going to sit in that (the wheel chair), I don’t want to get that bad’* (Male, P6).

Participants appeared to deal with the challenges of being physically active by rationalising their pain and its consequences as being a *‘normal’* part of the ageing process. For example, one stated *‘It (the pain) does bother me because you think to yourself when I was younger I could do that (referring to ADL), but now I can’t and that’s bound to be frustrating but what do you expect at my age?’* (FG 9). This notion was strongly endorsed in the focus group. Nevertheless, despite the CMP and current difficulties, there was a strong sense from participants that they had to keep *‘going’* and all participants portrayed a sense of defiance and determination. For instance, one female participant remarked *‘I can’t stop and worry about it (the pain) you just have got to keep going, if I stop who else will help me do the things I need to do? .’*

Emotional burden

Participants expressed frustration about the persistent nature of their pain and knowledge that it could exacerbate at any time. For instance, one female in the focus group stated that *'I think the worst part is its (the pain) going to come again... but you can't think this pain is here it's never going to go away, but you know it will come back in an hour or two hours'* (FG 19). The impact of the CMP on the participant's mood could be marked and cause a downward spiral. For instance, one stated *'I get fed up when the pain comes and it's bad, I think here it is again. It's a terrible cycle as you get pain, feel down and then it affects your pain.'* (Female, FG 13). The emotional toll of the pain and its consequences could impact also impact an individual's QOL.

Table 12.2 – Themes and subthemes derived from thematic analysis and illustrative quotations

Theme	Sub theme	Illustrative quotations
Psychological Concerns related to falls	<i>Fear of falling and adaptations (N=10)</i>	<i>‘The fear of falling over is always there. When my pain comes on real bad, I have no option but to stop doing certain things as I don’t want to upset the pain’ (FG15).</i>
	<i>Avoiding activities due to pain and FOF (N=7)</i>	<i>‘when I go out and do the shopping I do take the stick and that helps with my confidence and I don’t worry as much about falling’ (female FG 20).</i> <i>‘When my pain is there I avoid more activities, but also because I worry about falling over.’ (participant 6)</i>
	<i>Balance confidence (N=5)</i>	<i>‘I am less steady on my feet and of course that affects my confidence in my balance’ (participant 7)</i>
The experience of falls	<i>Feeling stupid and attributing falls to external factors (N=8)</i>	<i>‘I have fallen a couple of times it was my own silly fault.’ (Participant 7).</i> <i>‘my house was cluttered and I could not see my boxes on the floor and I just tripped over’ (Participant 7)</i>
	<i>The impact of pain on falls (N=6)</i>	<i>‘The pain can make you less steady and more likely to fall over’ (FG 16)</i> <i>‘I have so many things wrong with me, I am not sure what made me fall over’ (FG 15).</i>
The Importance of staying active	<i>Balancing physical activity and sitting (N=16)</i>	<i>‘it’s very important to keep active for me, as it helps my pain and gets me out there (in society)’ (FG 17)</i> <i>‘I have to sit down, but if you sit for too long I can’t get up straight away and walk. I have to stand up and get my balance and then take my time to take steps forwards’ (participant 3)</i>
	<i>The importance of keeping active and overcoming difficulties with ADL (N=14)</i>	<i>‘having the pain makes it harder to do the things I need to do (ADL), but I have just learnt to take my time and get on with them at my pace(the ADL)’ (FG 18).</i> <i>‘I have no option but to keep active and move to get things done...if you aint got no one there and you want something to eat what you going to do? You either have to starve or you have to get up and get the food. ’ (Participant 4).</i>
	Emotional burden (N=14)	<i>‘It’s (the pain) annoying isn’t it? I get more annoyed when I can’t do things. Sometimes I know it’s coming and I get annoyed.’ (FG 9)</i> <i>‘I can do less than I used to but I am still determined to do as much as I can. But what do you expect at my age?’ (FG 19).</i>

Key for table 12.2: N= number of participants providing comments for this theme, FG=focus group.

12.4 Discussion

To the researchers knowledge, the current study is the first to explore older adults' experiences of psychological concerns related to falling and actual falls, which is surprising given the fact CMP affects large proportions of the older adult's population (15). The quantitative literature, although relatively sparse until the PhD, appears unequivocal on the increased risk of falling and FOF in those with CMP, particularly multisite pain (11, 60, 261). The current qualitative study provides novel insights into the complexities of falls and concerns about falling among older adults with CMP. Specifically regarding falls, the sample within the study were less adamant that their pain was the primary contributing factor to their falls risk. While most in the current sample did acknowledge that their pain did increase their risk of falls, those that had fallen often attributed this to other external factors (e.g. a trip, a slip) and this way appeared to rationalise their fall. Participants often stated they had multiple physical health problems and it was simply not possible to say that their pain was the primary cause of their fall. Thus, the current study provides some preliminary evidence to suggest that the influence of pain on falls may not be simple and in reality other factors including other comorbidities also contribute. Moreover, the current qualitative study demonstrates that even when numerous large cohort studies (11, 60) and meta-analyses contained within the literature review of the thesis (230, 249) have demonstrated a robust link, it may in reality be an oversimplification of the relationship. However, the difficulty experienced by participants identifying pain as a contributor factor to falls has been elucidated previously in a large survey study (163). Morris et al (163) found that pain was significantly associated with falls yet none of the older adults that experienced 1671 falls attributed their fall due to pain when they were asked. Taken together with the fact that older adults within the current study tended to often view pain as 'normal', it may be that many do not recognise the impact their pain is having on mobility and falls risk.

Much in line with the wider qualitative literature investigating falls among people without CMP, participants within our sample reported feeling stupid and having a reduced confidence after a fall (49, 233). Indeed, the impact of falling among the study sample was often profound on the individual and much in line with the wider literature (297). Whilst FOF was clearly evident in those that had fallen, a number of people who had not fallen also experience this fear. In line with previous literature among individuals post hip fracture (298), the current results also revealed that the avoidance of activities increased as the FOF increased. This may explain the reasons why many of the participants made adaptations to their ADL. Generally, participants were much more forthcoming to ascribe their FOF, reduced confidence in their balance and avoidance of activities due to their pain. However, there was uncertainty among participants about whether pain or FOF led to the avoidance of more activities, with some stating that pain was important and others believing FOF was a more important contributor. Thus, again the relationship between pain, concerns about falling and subsequent avoidance of activities appears complex. The current study therefore provides important context from recent quantitative literature that has proposed that FOF contributes to the avoidance of activities in older adults with CMP (296).

The current results are similar to previous qualitative research regarding physical activity which has previously been considered in older adults with CMP. Specifically the sample reinforced earlier studies (294, 295) which found that older adults with CMP made self-imposed activity restrictions due to their pain but remained determined to “keep going”. In line with a previous study (295) the study sample reported they were determined to keep active spurred on by fear of losing independence in the future. The notion of “keeping going” was also a key theme from another qualitative study in older adults with CMP (299) although this was largely with reference to social activities as opposed to physical activity per se, but this determination to keep going appears across these qualitative studies to be a

common thread. Recently another qualitative study (231) found that older adults with chronic back pain experienced disruptions in their ADL, which was a common theme among the respondents and caused frustration particularly when participants reflected upon their abilities in previous years. Previous authors (294) have elaborated on the impact of self-imposed activity restrictions among older adults with CMP, although largely in fear of aggravating their pain. To this end, the first systematic review and meta-analysis in the thesis (chapter 2) (137) demonstrated that older adults with CMP are less active than people of similar age without pain. The current study gives a further insight into the challenges faced by older adults as many acknowledged that activity helps, but experience several barriers (increased pain, FOF). Specifically, the current study was able to highlight the careful balancing act that older adults with CMP undergo when trying to accommodate necessary breaks of resting (sedentary behaviour) but ensuring this was not too prolonged so they did not encounter difficulties 'get going' again.

Participants in the current study often rationalised their pain as just a normal part of the ageing process with comments such as '*what do you expect at my age?*'. This may have been a strategy by which the participants learnt to deal with and accept their pain and this notion has been previously reported in numerous qualitative studies (292, 294, 300). Older adults within the current study appeared more concerned about the impact of their pain on their ability to undertake ADL rather than the pain itself and this has also been reported previously (300). It was also evident from the last theme in the current study, that this difficulty with ADL caused frustration among the sample.

Whilst this study is a first in many regards, a number of limitations, which are largely attributed to the nature of qualitative research, must be acknowledged. First, the study used a convenience sample collected in one region in the UK from two different locations. Second, the sample size of 20 is relatively modest. Third, the centre managers acted as a gateway to

ensure the researcher did not recruit inappropriate participants (e.g. people with cognitive impairment) but this also introduced bias. Fourth, there was heterogeneity in the site, type and duration of pain within our sample. Finally, although it is not the intention of qualitative research, it should be stated these factors further compound the generalisability.

Clinical implications and future research

The current study suggests that older adults with CMP value the importance of physical activity to manage their pain and also to maintain their independence and prevent further physiological or psychological decline. Of particular clinical interest, is that older adults are less able to recognise their pain as contributing directly to their fall(s) and risk of falls. In recognition of this and the robust quantitative research confirming this link in the quantitative research chapters of the thesis, pain clinicians should enquire about falls since it seems likely that the older adults will not be forthcoming with this information. Since falls are a leading cause of morbidity and mortality in older adults (52) identifying those most at risk of falls is a clinical priority. Given that the current study demonstrates that maintaining independence with ADL is a primary cause for keeping active, clinicians should seek to encourage this, particularly since robust longitudinal evidence demonstrates physical activity prevents/delays the onset of difficulties in ADL (82). Future research is required to further explore older adults with CMP experiences of falls in particular given the lack of clarity in individuals attributing pain towards their falls risk and also the considerable individual and societal costs associated with falling. In particular, it appears that older adults with higher levels of pain interference (291) and higher levels of depressive symptoms and anxiety (40) are more likely to experience psychological concerns related to falls and actual falls (230). Research is required in particular to provide interventions and support these groups.

12.5 Summary of chapter

The current study is the first to explore older adults with CMP experiences regarding falls and concerns about falling. Participants recognised that their pain increased their falls risk, but were less forthcoming as one would expect given the robust quantitative results found in the thesis literature review and results chapters strongly suggesting a relationship. Older adults in the current sample were more clearly able to recognise that their pain increased FOF, reduced their balance confidence and resulted in the avoidance of activities. Throughout the interviews, participants remained adamant they have to ‘keep going’, which was largely spurred on by their fear of losing their independence. In particular, it appears from the current qualitative research that the earlier literature review and quantitative results chapter findings of strong associations between pain and falls may in fact be an over simplification. The findings of the current qualitative chapter go to serve the importance of adopting methodological diversity and utilising different research approaches, since the qualitative findings shed new light on the findings from the previous aforementioned chapters. It is now the intention of the final discussion chapter to integrate the findings from throughout the thesis with reference to the wider literature.

CHAPTER 13

DISCUSSION

Summary

The current discussion chapter provides an overview and discussion of the main findings within the PhD thesis with reference to the research aims and questions. Specifically the chapter provides a synthesis of the findings from all of the chapters with reference to previous literature. Moreover, limitations, strengths and directions for future research are carefully considered in the chapter.

13.1 Summary of key findings

This thesis set out with 3 primary and two secondary aims, which in essence were to better understand how i) physical activity/ sedentary behaviour, ii) psychological concerns related to falls and iii) falls are influenced by musculoskeletal pain characteristics in a sample of community dwelling older adults. Using a prospective publishing approach, the cornerstone for the development of the primary research was based upon the systematic reviews of each of these phenomena in line with best practice (69). The systematic review chapters were published in leading peer reviewed international journals and established that older adults with CMP are less physically active (chapter 2), may experience more psychological concerns related to falls (chapter 3) and be more likely to fall (chapter 4). Each of these enabled the researcher to identify the limitations and gaps within the literature and informed the development of the primary research for the thesis, thus ensuring it was novel.

Given the limitations identified within the literature reviews, and the subsequent research questions and aims, a mixed methods sequential explanatory model was employed focussing primarily on quantitative research enquiry. The first five quantitative research studies were all published in leading international peer reviewed journals. Specifically, chapter 7 established that the participants with CMP were sedentary for on average over 3.5 hours a day more than those without CMP. The chapter was the first to establish that the avoidance of activities due to FOF is independently associated with higher sedentary behaviour after adjustment of potential confounders. Chapter 8 investigated the CMP and falls relationship building upon the extensive systematic review in chapter 4 which included multiple meta-analyses. Specifically the results of chapter 8 found that the risk of falling and in particular recurrent falls is highest in those with multisite CMP. Moreover, the study within chapter 8 investigated the discriminative ability of the BPI to identify those at risk of falls and suggests it may prove useful to identify community dwelling older adults most likely to experience

recurrent falls. This was a new finding, no previous author had investigated the CMP and recurrent falls relationship despite the fact numerous falls prevention guidelines identify those who are at risk of recurrent falls need the most expansive assessment (56).

Chapters 9 and 10 were the first studies with an a-priori aim to investigate the relationship between musculoskeletal pain and psychological concerns related to falls. Specifically chapter 9 established that after the adjustment for previously established risk factors, pain causing interference is associated with each of the four common psychological concerns related to falls. Chapter 10 built on this and found that multisite CMP and higher pain severity are associated with lower balance confidence among the participants within the thesis. The final quantitative chapter (chapter 11) established that the previously identified mobility limitations and higher falls related risk factors are associated with reduced HRQOL in those with CMP. Thus, this chapter established that the impact of mobility limitations and fall related factors including increased psychological concerns are marked in older adults with CMP. Moreover, the wider impact of these factors on HRQOL also appears profound. Given that chronic musculoskeletal disorders are leading causes of YLD (1) and affect approximately 50% of community dwelling older adults (13) the potential implications of the findings from the literature review and quantitative results chapters is profound.

Although quantitative research has a number of potential advantages and enables a researcher to make statistical inferences, there are some criticisms that this approach can lack depth and context from the perspective of the individual (180, 186, 301). Given this, chapter 12 investigated the personal experiences of a convenience sample with CMP from the study regarding each of the three phenomena within the PhD study in the final part of the sequential explanatory model. This latter qualitative work suggests that the relationship between pain symptoms and each of the phenomena of interest is not as explicit as the quantitative research would suggest. This indicates that the results from the quantitative research may possibly be

an over simplification of the relationship between pain and mobility outcomes. However, this may in part be due to the finding that participants reported their pain as just a normal part of the ageing process or due to potential cognitive deficits limiting their ability to attribute their pain as influencing these phenomena. Moreover, one should note the limitations briefly of qualitative research and in particular the small purposefully selected sample size which clearly does not enable generalisation beyond the sample interviewed. Considering these points, adopting the mixed methods approach enabled the limitations of each research approach to be addressed within the other paradigm and complimenting each other's strengths (174). Given this, it is now the intention of the researcher to consider the synthesis of the findings from the quantitative and qualitative research with reference to the wider published literature regarding each of the three phenomena and consider the relevant aims for the thesis.

13.2 Musculoskeletal pain and physical activity/ sedentary behaviour

The first primary aim for the thesis was to determine if older adults with CMP engage in less physical activity and more sedentary behaviour than older adults without CMP. The findings of the meta-analysis within chapter 2 and results chapter 7 are consistent, demonstrating that older adults with CMP are significantly less physically active and more sedentary than older adults without CMP. Thus, the thesis has addressed this specific aim within its available resources. Moreover, the results from chapter 7 suggest that the avoidance of activities due to FOF is the largest contributing factors to this excess sedentary behaviour, a novel finding. Other factors that also appear to contribute to the excess sedentary behaviour include reduced functional mobility (slower TUG scores) and higher BMI. Previous research has demonstrated that older adults with CMP have marked mobility limitations (25) and recent research has also identified obesity may prove an important mediator of the pain and disability relationship (302). Quantitative research regarding the avoidance of activities in

older adults with CMP is sparse which is surprising given the rise of the fear avoidance model in relation to pain (48). However, a study (117) previously identified that fear avoidance beliefs are predictive of disability in older adults with CLBP, thus highlighting the potential problematic nature of such behaviour. Previous research has demonstrated that following a hip fracture individuals tend to avoid more activities (298). However, chapter 7 was the first study to establish a link between FOF and sedentary behaviour, which is important given the latest meta-analysis demonstrating higher levels of sedentary behaviour are predictive of cardiovascular and cancer related mortality independent of physical activity (35). Given this, future prospective research is clearly required to disentangle these relationships, particularly given the cross sectional nature of the study in chapter 7. Future research should also consider if interventions that target both pain symptoms and activity avoidance (possibly structured physical activity) can lead to increases in physical activity, reductions in sedentary behaviour and improvements in overall health.

The qualitative research in chapter 12 regarding physical activity/ sedentary behaviour was particularly enlightening within the limitations of the research approach (i.e. small convenience samples from two centres in one city) and forms part of the researcher's attempt to address the secondary aim 5. Specifically the convenience sample with CMP appeared to value physical activity and this was spurred by a fear of losing independence in the future. The notion that participants felt they had to "keep going" was tangible and this has been reported in previous qualitative studies in older adults with CMP (299). Recently some authors (294) conducted qualitative research that identified from their purposive sample there was a rational desire to avoid pain which resulted in the avoidance of activities, but recognised this in the long term has the potential to compromise autonomy. Participants within the PhD research seemed particularly motivated to stay active in recognition of the danger of losing one's independence in ADL in the longer run if they 'give in'. This is a fact

borne out in a recent meta-analysis of longitudinal studies (82) which found that incident ADL disability was reduced among those most physically active by approximately 50% over a 3-10 year period (RR 0.51, 95% CI: 0.38, 0.68; $p < 0.001$).

One key theme from chapter 12 was that participants stated that they avoided activities not only because of their FOF but also because of fear of exacerbating their pain (i.e. in line with the fear avoidance model). Thus, whilst the MSAFFE instrument specifically enquires about avoidance of activities relating to falls, it is possible that some participant's scores within this scale were attributed due to fear of eliciting their pain symptoms. The current research did not utilise a measure to investigate fear avoidance beliefs which may have helped understand these relationships in more detail. That decision was primarily because this would not been a novel finding and there is always a need to minimise burden placed upon participants. Clearly future research is required to consider this further, which should include a prospective design and once again also employ qualitative research and also consider physiological balance, pain avoidance beliefs and FOF.

In summary, the findings from the PhD established that older adults with CMP are less active and more sedentary than older adults without CMP (primary aim 1). The contributing factors to this appear to be due to FOF and subsequent activity avoidance and reduced functional mobility. Moreover, the qualitative research identified that some of the avoidance of activities may be due to fear of exacerbating pain symptoms, which is in line with the fear avoidance model (secondary aim 5). Future prospective research is required to disentangle these relationships and should seek to capture physiological balance and mobility objectively in addition to also considering fear avoidance beliefs and testing the observed relationships within the cross-sectional studies.

13.3 Musculoskeletal pain and falls

Primary aim 3 was to establish if older adults with CMP are more likely to fall than older adults without CMP. There is strong evidence from the fourth literature review chapter that pain (particularly CMP) is associated with falls (particularly recurrent falls). Indeed, although still limited, there was more research investigating the relationship between pain and falls than the other phenomena of interest in the PhD, which is unsurprising to some extent given the fact preventing falls is an international priority (63). Nevertheless, the study within chapter 8 was the first with an a-priori aim to investigate the relationship between number of CMP sites and recurrent falls, a gap which was identified in the literature review. The results were novel, indicating the risk of recurrent falls is greatly increased in those with multisite pain and no such relationship was identified in those with single site CMP. Since the publication of the findings from chapters 4 and 8, one large study (60) also investigated the relationship between bothersome pain over the last month and recurrent falls in a nationally representative sample over 35.3 million older adults. Much in line with the meta-analyses in chapter 4, the authors (60) found 19.5% experienced recurrent falls in the past year and the authors demonstrated that the risk of falls increased with the number of pain sites affected. Moreover, the authors (60) also identified that FOF increases with increasing number of pain sites. Other quantitative research has since been conducted following the publication of the findings in chapter 4 and 8, including Lazkani et al (303) and Asai et al (304) which have both confirmed the PhD findings that CMP and in particular that at multisite is associated with falls. However, these authors have not investigated the relationship with recurrent falls, which is surprising given the considerable expenditure and injuries associated with those who repeatedly fall (61).

Despite the unequivocal research demonstrating the increased risk of falls in older adults with CMP, this relationship was less evident in the convenience sample of older adults with CMP

when interviewed in chapter 12 (secondary aim 5). In fact, few appeared to attribute their pain as a direct cause of falls or as increasing their falls risk which appears to be largely due to the fact they had many other comorbid physical complaints and any falls were often rationalised by external events that they felt could be explained. However, difficulty recognising pain as a contributing factor to falls has been identified within previous quantitative literature. For instance in one large study (163) when over 1,000 participants were asked to give a reason for their fall, despite the fact the authors found a significant association between pain and falls, not a single older adult attributed their pain as a reason they fell. Moreover, the authors (163) did not comment on the pain and falls relationship in their own paper. Indeed, this lack of recognition in published papers was a common feature within the studies included in the literature review chapter. Within the focus group, when directly asked in a closed question if pain increased their risk of falling only 41.6% (5/12) agreed, which was the lowest percentage response to the questions within the focus group. Whilst this is not generalisable beyond the sample in question, it does pose the question, why might participants not recognise pain as a risk factor for falls? This is undoubtedly a complex question and one which is considerably beyond the scope and remit of the PhD and clearly warrants future consideration. Nevertheless, this could potentially be due to competing comorbidities being more pressing or possibly due to the cognitive deficits associated with pain (11). Moreover, this could as previously stated be explained by the fact the convenience sample deemed their pain as very much a normal part of ageing which has been reported previously in the literature (299, 300).

Regarding the possible relationship between pain and falls, Leveille et al (11) in their pioneering paper proposed 3 possible mechanisms that could account for the pain and falls relationship namely, local joint pathology, neuromuscular effects of pain, and central mechanisms where pain interferes with cognition or executive function (305). Specifically,

the relationship between the onset of musculoskeletal pain and alterations in physiological balance and any adaptations in physical activity/ sedentary behaviour warrant investigation given the findings from this thesis. There could be a critical point at which to work with the older adults to possibly prevent the ensuing cycle developing. Another key factor that could develop at this time is alterations in gait due to chronic pain, which may increase postural sway and lead to instability (11) thus possibly resulting in increased sedentary behaviour and accelerated sensorimotor deconditioning (82). However, clearly future prospective research is required to disentangle these relationships in recognition of the limitations of the research within this PhD. Just as important is the development of future interventions, with structured physical activity demonstrating promise in addition to more innovative strategies to reduce unnecessary avoidance and gait alterations in those with CMP such as Pain Neurophysiological Education. Finally, Leveille et al (11) propose that cognitive deficits could account for the pain and falls relationship. Given the fact that cognition was not formally assessed, the contribution of this on reporting could not be determined and would have required considerable resources. In addition, a study (115) recently demonstrated that FOF is independently associated with reduced brain volume in the bilateral superior frontal gyrus and left supplementary motor area, which are key areas for executive function and processing. Thus, given the findings pertaining to FOF in the thesis, the excessive concerns regarding falls may also influence executive function and falls risk.

Although the thesis established novel findings in chapter 8, given the cross sectional nature of the research possible explanations for the pain and falls relationship cannot be firmly extended beyond the aforementioned. There are a number of further limitations to the primary data collection in the PhD of the pain and falls relationship. The primary limitation is the falls data were collected retrospectively. Although retrospective history of falls is the most accurate predictor of future falls (58) prospective measurement through calendars is the

optimal method. However, although conducting monthly prospective falls calendars was considered at the commencement of the PhD, it was deemed beyond the scope and available resources of a PhD. Moreover, recent research (306) has given further confidence to the use of retrospective falls history in community dwelling adults. The authors (306) compared retrospective and prospective falls data from two large population cohort studies (both >1,000) and conclude that '*costly collection of prospective data gives similar rates to cheaper retrospective report methods*'. Nevertheless, future prospective research is required to better understand the pain and falls relationship and this should prioritise the investigation of number of pain sites and recurrent falls in particular. Despite the recent nationally representative study (60) which also considered retrospective falls data and number of pain sites, no study has prospectively considered the pain and recurrent falls relationship. Moreover, there is an urgent need to investigate interventions that seek to reduce pain symptoms and falls. To this end, physical activity may be the most suitable option given that an umbrella review of meta-analyses of RCTs demonstrated exercise is the most effective intervention to prevent falls (59) and that exercise is effective in reducing pain and disability in this population (39).

13.4 Musculoskeletal pain characteristics and psychological concerns related to falls

Primary aim 2 set out to determine the relationship between musculoskeletal characteristics and psychological concerns related to falls in community dwelling older adults. The second literature review chapter (chapter 3) and 9th and 10th results chapters provided several novel findings in the pursuit to address this aim. Firstly, the second literature review chapter (chapter 3) was the first review of its kind to attempt to investigate if pain is associated with psychological concerns related to fall. In addition, the chapter provided a possible explanatory rationale why pain may be related to each of the psychological concerns related to falls and provided the platform for the primary studies. Given the fact the previous

literature (11, 24) and the earlier results found that pain interference is particularly associated with falls and mobility limitations, chapter 9 focussed on pain interference on each of the psychological concerns. In fact, it was the first study to investigate the influence of pain interference on each of these. The results demonstrated that even after adjustment for factors identified in a recent systematic review (43) they remain important predictors. Moreover, given the previous findings on the impact of pain interference on falls (11), it was possible to conduct exploratory sub group analyses which demonstrated some variation in the variance explained in each of the four concerns in the models between participants with and without a history of falls. This goes to support research that falls history is clearly important in their development (151) but is by no means a decisive factor and those individuals that have not fallen also experience these too.

The findings within chapter 10 attempted to disentangle the relationship between musculoskeletal pain characteristics and balance confidence. Interest in balance confidence is considerable due to the fact that it is widely measured in clinical practice, with the ABC scale commonly used and the fact there is an abundance of wider research investigating the negative consequences of reduced balance confidence. For instance, lower balance confidence is associated with restriction of physical activity, reduced participation in ADL and increased dependence (49, 124) and given the aforementioned findings, this is important. Moreover, balance confidence has been the target of numerous interventions and several meta-analyses have demonstrated physiotherapy approaches can improve this (268). Therefore, the finding that multisite pain and higher pain severity are strongly associated with reduced balance confidence is concerning and has important implications. The results of increasing impairments in balance confidence with multisite pain are in line with the increased risk of multisite falls in this group found in chapter 8 and more recently in a nationally representative study (60).

The qualitative results within chapter 12 represent the first study of its kind to investigate the experiences of a sample of people with CMP on each of the psychological concerns related to falls (secondary aim 5). The results of the qualitative chapter 12 compliments and support the quantitative results to some degree in that psychological concerns related to falls were not isolated to those that have fallen, but they appear a stronger theme in those that have fallen. This has also been identified in previous wider qualitative literature to some degree, for instance one study (307) found this relationship and also endorsed another key theme in the qualitative results of participants feeling stupid and embarrassed from falling over. Much in line with the theme regarding falls, participants had some difficulty identifying if it was the pain or psychological concerns that increased their falls risk. Within the wider literature there has been some debate (40, 41) stating researchers often mistakenly and interchangeably use each of the four common psychological concerns related to falls. The research in chapter 9 demonstrates that pain is strongly interlinked with each of these although some variation was noted. However, when discussing psychological concerns related to falls with the convenience sample with CMP it was evident that the boundaries among each four phenomenon were blurred. It appears that participants were most able to identify with issues pertaining to reduced balance confidence, although again participants often did not directly attribute this with pain characteristics. Thus, although some convergence is evident between the quantitative findings within the thesis, more prospective research is required to better understand these relationships. The cross sectional nature of the quantitative work and small convenience sample limit the ability of the research findings to make any definitive conclusions regarding pain and psychological concerns in community dwelling older adults.

13.5 What is the link between musculoskeletal pain characteristics, physical activity/sedentary behaviour, falls and concerns about falls?

Due to the limitations of the cross sectional design employed in the thesis, it is not feasible to determine with any degree of certainty the directionality of specific relationships beyond the associations outlined above and also those within the unique discussion contained in each results chapter (chapters 7-11). A randomised control trial is required to address the issue regarding causality. Although the 5 quantitative research chapters demonstrate clear associations between pain characteristics, sedentary behaviour, falls and psychological concerns related to falls, clearly prospective research is required to disentangle the directionality of these relationships and relative contribution of each of these. Whilst the exact direction between variables is unclear, it may be in the first instance that as pain arises, older adults experience alterations in physiological balance and gait, due to their pain which requires adaptations and self-imposed limitations within their movement. If this continues it can accelerate sensorimotor deconditioning (82), consequently further reducing physiological balance, increasing concerns about falls and more self-imposed activity restriction, and a vicious cycle develops. Consequently, falls risk is understandably greatly increased as sarcopenia may develop (98) thus further predisposing the individual to heightened falls risk and activity restriction to remain safe. Possible strategies to overcome this problem may include early identification of pain so that such a cycle does not develop. Moreover, educational interventions targeted at older adults regarding their belief that pain is a normal part of the ageing process and inevitable (300) should be developed. This may lead to older adults seeking help at an earlier stage for their pain and possibly prevent some of the potential circumstances that arise with mobility limitations and falls risk from CMP. In addition, chapter 11 demonstrates that these mobility limitations and falls risk factors also have a wider impact contributing to a reduced HRQOL in older adults with CMP (secondary aim 4).

13.6 Clinical implications

There are numerous clinical implications arising from this work and although the respective clinical implications have been discussed in each results chapters own discussion (chapters 7-12) these will briefly be summarised. Clearly, the results throughout the thesis highlight that CMP, particularly those with multisite and severe pain are at great risk of falls and increased amounts of psychological concerns related to falls. Given this, clinicians, including physiotherapists, should seek to identify older adults with pain and may use the BPI severity and/ or interference subscale for these purposes. If a person is identified as having pain the number of pain sites should be ascertained in recognition of the increased risks associated with those with multisite pain. Clinicians should therefore adhere to pain management guidelines on the appropriate management of pain in older adults. Physical activity interventions should be considered first since it has favourable outcomes on pain and disability (39), psychological concerns related to falls (268) and falls (59). The exact nature of the physical activity (the frequency, intensity, type and time) has not been investigated within older adults with CMP. Therefore, standard physical activity including balance, lower limb strengthening and increasing habitual physical activity should be encouraged (39, 59). Clearly given the potential pain, risk of falls and reduced mobility in older adults with CMP, physiotherapists could oversee this process and in particular develop modifications in physical activity programmes. More specific clinical implications are considered for the relationship between pain and physical activity/ sedentary behaviour (chapters 2 and 7), falls (chapters 4 and 8) and psychological concerns related to falls (chapters 3, 9 and 10) in the respective chapters.

13.7 What are the strengths of the PhD?

This PhD adopted a prospective publishing approach ensuring that all findings were made available in the public domain as soon as possible after the new knowledge was generated (fulfilling the FHEQ of meriting peer review publication). Importantly, all of the research studies contained within the thesis were based upon the findings of robust systematic reviews and appraisal of the literature (working towards the FHEQ criteria that PhD candidates must demonstrate *‘the systematic acquisition and understanding of a substantial body of knowledge at the forefront of a discipline’*). The three systematic review chapters provided the foundation for the thesis, enabling the researcher to identify limitations and gaps within the pre-existing literature and thus ensuring the research fulfils the criteria of the FHEQ of creating new knowledge to extend the forefront of a discipline. In addition to contributing towards another key FHEQ criteria PhD candidates are expected to meet *‘a detailed understanding of applicable techniques for research and advanced academic enquiry’*. The 5 quantitative results chapters and qualitative results chapter have all been published in international peer reviewed journals and collectively the contents of this thesis have received independent appraisals and ultimately been endorsed by in excess of 25 expert peer reviewers. All of this ensured that the findings were novel throughout the PhD. The PhD also employed a mixed methods sequential explanatory approach, recognising the importance of methodological diversity and different strengths and limitations within a quantitative and qualitative approach and using these to supplement one another. Importantly, since the academic currency is peer-reviewed publications, the endeavours of the thesis and using a prospective publishing approach has enabled another key FHEQ to be fulfilled regarding the demonstration of the *‘qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and largely autonomous initiative in complex and unpredictable situations, in professional or equivalent environments’*.

There are numerous other methodological factors that also contribute to the strength of the thesis. First, the data for the substantive quantitative phase was collected across multiple sites over London in an attempt to increase diversity within the sample. In recognition of the fact only one previous study (11) had assessed CMP in accordance with international guidelines (61) and investigated falls, the current study set out to assess pain in accordance, thus increasing the likelihood of understanding the pain and falls relationship (and other phenomena too). Moreover, the research was conducted in line with the PROFANE falls taxonomy (56) and a fall was defined in advance. The literature review in chapter 4 demonstrated very few authors had defined a falls and this has been criticised by some (55). Moreover, chapter 9 is one of only a handful of studies (40, 44) that have considered all four psychological concerns related to falls in one single study. In addition, the research was guided by PPI involvement from the outset and has also resulted in local change in practice with a local community falls service now routinely assessing pain with BPI in light of the PhD results in chapters 4 and 8 (see letter from Greenwich community falls service in Appendix).

In summary, there are multiple methodological and pragmatic strengths to the PhD. The work has resulted in 9 publications in international peer review journals and been carefully critiqued and approved by an excess of 25 independent international peer reviewers. All primary research was informed by a systematic search and appraisal and has satisfied peer review and the researcher's journey can be traced prospectively through the publication archives demonstrating the researcher's intention from the outset. This is clearly distinct to the traditional 'PhD by publication', where a candidate often retrospectively brings together 3-5 publications on a similar topic and produces a 3-5,000 word summary statement. Moreover, this approach prepared the researcher for academic independence.

13.8 Limitations of the thesis

Nevertheless, there are numerous limitations within the thesis which have been dealt with extensively in the results chapters and previous text in this chapter. In brief, this includes the fact that the population recruited was not a random sample and as such the results may not be generalisable to other populations. In addition, cognition was not assessed within the primary studies and entering people in the study with some degree of undetermined cognitive decline may have influenced the results. Nevertheless, no participant was unable to complete the tasks in the study suggesting the degree of cognitive decline was not marked. Perhaps the most marked limitation is the cross sectional nature of the quantitative research, thus precluding definitive theory that draws together all of the key findings from the 5 quantitative results chapters. However, given that this is a project in which there were limited financial resources and all data were undertaken by the sole researcher a balance had to be struck. Another limitation is that it is unclear exactly how representative the convenience sample with CMP is and so the themes developed from the qualitative synthesis may well not reflect those of older adults in general.

13.9 Future Research directions

As expressed throughout the discussion chapter there is a need for future prospective research to disentangle the relationships observed within the current study. This should follow the PROFANE (56) falls taxonomy and falls should be monitored prospectively. More specifically, further qualitative research should seek the personal experiences of larger numbers of older adults with CMP to better understand the impact of pain on each of these phenomena. This should also consider discussing in more detail why older adults do or do not consider pain as a risk factor for falls and increased concerns about falls. All of this should feed into the development of appropriate interventions that should be tested through

RCTs. Specific ideas for future interventions should consider the role of lower limb strength and balance training, given the fact this has been demonstrated to improve pain/ disability (39) and reduce falls in general community dwelling older adults (55, 59). One possible option that should also be considered is tai chi again given its favourable benefits in preventing falls (55, 59) but also because this may improve pain symptoms(308) and balance confidence (268).

13.10 What are the novel findings and original contributions of the PhD?

There are several novel contributions of this thesis which include:

1. First systematic review and meta-analysis to establish older adults with CMP are less active than controls (chapter 2).
2. First systematic review to investigate and explore the association between pain and psychological concerns related to falls (chapter 3).
3. First systematic review and meta-analysis investigating musculoskeletal pain and falls in community dwelling older adults (chapter 4).
4. First research paper to establish that the avoidance of activities due to FOF is associated with sedentary behaviour in community dwelling older adults (chapter 7).
5. First research paper to establish that older adults with multisite pain are at greatest risk of falls and in particular recurrent falls (chapter 8).
6. First research paper to investigate pain characteristics associated with each of the psychological concerns related to falls and disentangle the differing risks in those with and without a falls history (chapter 9).
7. First research paper to establish that multisite pain and higher levels of pain severity are associated with the lowest levels of balance confidence (chapter 10).
8. First research paper to demonstrate that the mobility limitations and falls risk factors contribute to the reduced HRQOL in people with CMP (chapter 11).
9. First qualitative study to investigate the experiences of older adults with CMP towards psychological concerns related to falls and actual falls (chapter 12).

CHAPTER 14:

CONCLUSION

At the start of this thesis, the overarching aim was to investigate how CMP may influence physical activity/ sedentary behaviour, falls and psychological concerns related to falls. The framework chosen to do this was a pragmatic mixed method sequential explanatory model that sought to disseminate the findings at the earliest opportunity. It may be reasonable to assume that the work undertaken in this thesis has provided novel findings in each regard which has extended our understanding of these key and neglected areas. Moreover, the research has been disseminated in multiple international peer review journals, thus meeting the criteria for peer review.

In conclusion, from this thesis it appears that CMP makes older adults less active and more sedentary and that the avoidance of activities due to FOF appears to independently contribute to this. Moreover, this may in part be rational, because CMP and in particular those with multisite pain and more severe pain, are at increased risk of falls and experience more psychological concerns related to falls. Unsurprisingly, the heightened falls risk factors and mobility have a marked effect on older adults with CMP HRQOL, thus demonstrating the wider impact of these phenomena on the older adult. The qualitative research highlighted that the relationships between musculoskeletal pain and falls, FOF and activity appear to be less concrete and that in reality other factors may also play an important role. Taken together, there is a need to develop interventions that seek to improve pain symptoms whilst also addressing falls risk and FOF. Considering the wider literature, structured physical activity may be a viable option to achieve this and an RCT is warranted to evaluate this proposal. The qualitative interviews revealed that the threat of losing independence appeared to be a strong motivator for the sample to remain active, thus clinicians should actively seek to encourage and promote older adults with pain to maintain activity within daily life wherever safe and possible.

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