Understanding the use of diagnostic imaging and its role in decision-making in musculoskeletal pain conditions affecting the lower back, knee, and shoulder

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PhD 2023

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A thesis submitted in partial fulfilment of the requirements of Manchester Metropolitan University for the degree for the Doctor of Philosophy

Department of Health Professions

2023

Acknowledgements

It is reasonable to say that this thesis would not be possible without the support, guidance, and constructive feedback from a wide range of people and organisations.

Firstly, I would like to thank my supervisory team; Professors Chris Littlewood, and Gillian Yeowell, and Dr Bruno Mazuquin. Additional thanks to Professor Nadine Foster and Professor Lisa Dikomitis who supported the earlier stages of this PhD.

Having started this PhD under an ACORN studentship at Keele University, before transferring to Manchester Metropolitan University, who continued to honour the remit of the studentship – thank you to both Universities.

To the Chartered Society of Physiotherapy Charitable Trust who awarded me a research grant to support the qualitative investigation within this thesis.

To my employer, Connect Health for supporting me with the provision of protected research time to undertake the PhD.

Thanks to my family that have supported me throughout this journey, putting up with the early mornings, late nights, working on holiday and more!

A special thanks is extended to Luna, for always being willing to join me for a walk as I procrastinate; and to Zara, for always willing to wake me up in the early hours to ensure I'm in the office…

Abstract

Musculoskeletal (MSK) pain conditions are one of the most common reasons for primary care consultation. The epidemiological evidence suggests that the most common body sites for MSK pain are the lower back, knee, and shoulder respectively, with most presentations being non-traumatic in nature. In turn, this PhD focuses on non-traumatic MSK pain conditions affecting the lower back, knee, and shoulder.

The use of diagnostic imaging has been acknowledged as a challenge within the NHS, with year-on-year increases in the number of diagnostics being requested contributing to extra demand on radiology services. In many situations, there is considerable clinical uncertainty in relation to the diagnosis and when this uncertainty exists, it has also been reported that scan results are perceived by patients as authoritative.

This PhD thesis used multi-methods design to achieve the aims of better understanding the reasons for requesting imaging, and how the results are used. Two scoping reviews are presented which outline the recommendations for imaging use from clinical practice guidelines, and how these are largely consistent with recommendations within public-facing websites. These recommendations outline how the routine use of diagnostic imaging is discouraged, reserved for cases where specific **or** serious pathology is suspected or where the person is not responding to initial management and the result is expected to change clinical management.

Two qualitative studies are then presented that explore why and how imaging is used from the perspective of the patient and the clinician. These findings consider the role of patient expectations, making sense of symptoms, managing uncertainty, and involvement in decision-making.

The findings of this PhD conclude with recommendations for practice, policy and research with a focus on the potential of personalised care and communication skills as methods to optimise diagnostic imaging use. A foundation has been established upon which further research could be undertaken.

Outputs and dissemination

Manuscript publication

Cuff et al. (2020). Guidelines for the use of diagnostic imaging in MSK pain conditions affecting the lower back, knee, and shoulder: A scoping review. MSK Care, 18 (4), 546-554 (Appendix 1)

Cuff et al. (2022). Recommendations on public-facing websites regarding diagnostic imaging for low back, knee, and shoulder pain: A scoping review. PEC Innovation, 1, 100040, 1-11. (Appendix 9)

Research Awards

Scheme B research grant awarded by the Chartered Society of Physiotherapy Charitable Trust (CSPCT) – PRF/19/BO5 (Appendix 13) - **£23,523.44**

Conference presentations

- European Congress of Shoulder & Elbow, Den Bosch, NI 2019
    - Podium presentation – Scoping Review of Clinical Practice Guidelines (Chapter 2)
- PhysioUK 2020 (Virtual)
    - Poster presentation - Scoping Review of Clinical Practice Guidelines
- British Elbow and Shoulder Society – Scientific Meeting 2021 (Virtual)
    - Invited presentation to discuss the findings of the Scoping Review of Clinical Practice Guidelines

- Therapy Live 2022 (Virtual)
    - Invited presentation to discuss the findings of the Scoping Review of Public-facing Websites (Chapter 3)
- British Elbow and Shoulder Society – Scientific Meeting 2021 (Virtual)
    - Invited presentation to discuss the findings of the Scoping Review of Patient Facing Websites
- European Society of Shoulder and Elbow Rehabilitation – Advanced Practice Scientific Congress, Dublin 2022
    - Invited presentation to discuss the findings of the Scoping Review of Patient Facing Websites
- Primary Care – Best Practice Show, Birmingham 2023
    - Invited presentation to discuss the findings of the Qualitative Investigations (Chapters 4 – 6)

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Frequent abbreviations

CPG – Clinical Practice Guidelines

EULAR – European League Against Rheumatism *now known as European Alliance of Associations for Rheumatology*

LBP – Lower/Low Back Pain

MRI – Magnetic Resonance Imaging

MSK - Musculoskeletal

NICE - National Institute for Health and Care Excellence

OA - Osteoarthritis

SDM – Shared Decision Making

SIJ – Sacroiliac Joint

USS – Ultrasound Scan

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Chapter 1 – Setting the scene.

Summary

This chapter sets the scene and provides the context for this PhD thesis which aims to better understand the reasons for requesting imaging for patients with common musculoskeletal (MSK) pain conditions, including lower back (LBP), knee, and shoulder pain. The burden of MSK pain on a background of increasing imaging rates is introduced, alongside relevant terminology. The justification for undertaking this programme of work is considered prior to the aims and objectives of this PhD being presented.

1.0 Introduction

In the UK, 22% of the total burden of ill health is attributable to MSK conditions, with LBP being the leading cause of years lived with disability (1,2). It is estimated that 18.8 million people are living in the UK with an MSK condition, with the majority of MSK conditions following non-traumatic onset (2,3). This includes 4.1 million people living with knee osteoarthritis. MSK conditions have an associated economic impact of 28.2 million lost working days per year (2,4).

MSK pain conditions are one of the most common reasons for primary care consultation (5). The epidemiological evidence suggests that the most common body sites for non-traumatic MSK pain are the lower back, knee, and shoulder (5,6). In turn, this PhD focuses on non-traumatic MSK pain conditions affecting the lower back, knee, and shoulder. Most of these non-traumatic presentations cannot be attributed to a specific biomedical diagnosis, and are often considered within a

generic label (5) example, non-specific LBP (7) rotator cuff-related shoulder pain (8).

For nearly all of those presenting with non-traumatic LBP, knee, or shoulder pain, where treatment is perceived to be indicated, the recommended first-line clinical care is non-surgical management (9). Recommended first-line interventions include advice and education, exercise therapy, activity modification, and pharmacological interventions including analgesics and non-steroidal anti-inflammatory medications (9,10). More invasive treatments such as injection therapy or surgery are reserved for a smaller proportion of patients with either clear pathology that indicates a particular type of invasive intervention (e.g. epidural injections of local anaesthetic and steroid in people with acute and severe radicular pain as per the National Low Back and Radicular Pain Pathway (11) within the UK or for patients whose symptoms persist, are not acceptable to the patient, and have not responded to previous non-surgical treatment (3). Whilst this 'tiers of treatment' or 'stepped care' approach is recommended, the indications for proceeding to surgery in those that have not previously responded to non-surgical management have been challenged. For example, with time to surgery a factor that may contribute to a worsened prognosis for people with sciatica, recent evidence has proposed that discectomy might be considered an early management option for the benefits of earlier improvement in leg pain when compared to non-surgical treatment or epidural injections (12–14). In contrast, for those with rotator cuff-related shoulder pain, superior outcomes have not been demonstrated with surgery compared to non-surgical approaches (12)

Whilst once reserved exclusively for the medical profession, the use of diagnostic imaging, including x-ray, USS, and MRI is now within the scope of practice for other professions within the primary or intermediate care team including nurses, pharmacists, and physiotherapists within the UK. The rising use of diagnostic imaging within primary care has been acknowledged as a challenge within the NHS, with year-on-year increases in the number of diagnostics being requested contributing to extra demand on radiology services that exceeds capacity (15,16). In many situations there is considerable clinical uncertainty in relation to the diagnosis to which symptoms of pain and reduced function can be attributed. For example, whether buttock pain relates to the lower back or hip, or whether deltoid-region pain relates to the neck or the shoulder. When this uncertainty exists, it has also been reported that scan results are perceived by patients as authoritative (17).

1.1 Terminology

Prior to outlining the rationale underpinning further study, it is important to introduce key terminology that is utilised throughout this thesis.

Diagnostic Imaging

Diagnostic imaging refers to a variety of different modalities and techniques **(Figure 1)** that enable the visualisation of the inside of the body in a non-invasive manner. Common forms of imaging within an MSK context include:

X-ray – sometimes referred to as a plain radiograph, this technique relies on radiation passing through the body. As the x-ray (a type of radiation) passes through the body, energy from the x-rays is absorbed at different rates, in

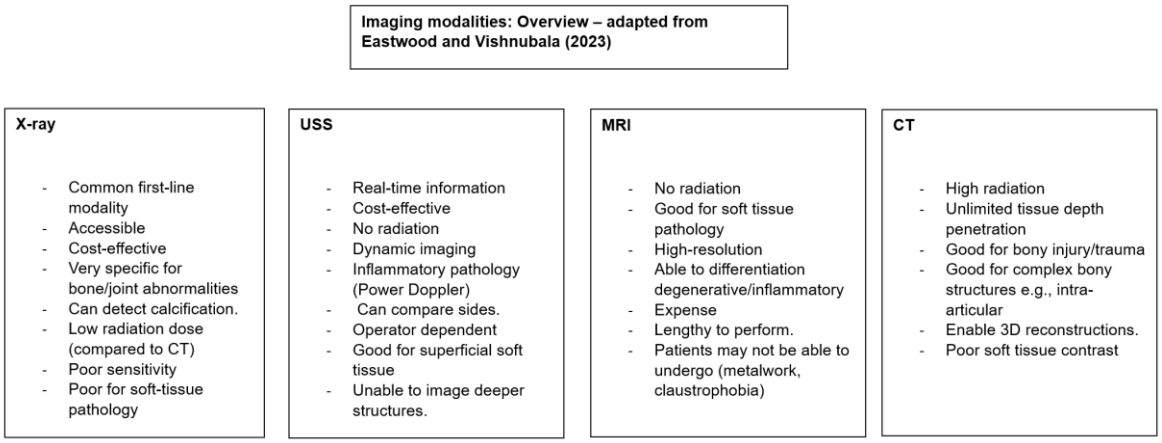
turn producing an image. In a MSK context, this modality is predominantly utilised to assess bones and joints.

USS – this technique utilises high-frequency sound waves to create an image using a probe. This also does not utilise radiation and is typically used to obtain images of soft tissue structures.

MRI – this technique utilises magnetic fields to create a detailed image and does not utilise radiation. Whilst predominantly used to obtain images of soft tissues, it can be used to examine most body structures.

Computerised Tomography (CT) – this technique utilises x-rays and digital platforms to create detailed images that includes blood vessels, viscera, and bones. This is a specialised technique involving radiation and is a less commonly used technique in primary or intermediate care.

Figure 1: An overview of diagnostic imaging modalities and techniques.



In addition to ‘diagnostic imaging’ the terms ‘investigation’, ‘diagnostic’, and ‘imaging’ are utilised interchangeably in the literature when referring to different

modalities or techniques that enable visualisation of the inside of the body (16,18–20).

Non-traumatic

When looking across the literature, a standardised definition of **non-traumatic** does not exist in the field of MSK medicine. As such, for the purpose of this thesis it is defined as pain that is MSK in origin in the absence of a single definable incident of sufficient velocity or force to invoke tissue injury such as a fracture or dislocation.

1.2 Rationale underpinning further study.

Reports have described that in the five years between 2011/12 and 2016/17 there was a 16% increase in the use of diagnostic imaging within the National Health Service (NHS) in England (15). This data was published in 2019 and following the impact of COVID-19 on service delivery and subsequent recovery, this is the most recent, stable estimate of imaging use. Ninety percent of all NHS consultations occur within primary care (21), with MSK conditions accounting for 20% of all GP consultations (22). With the total burden of ill health attributable to MSK conditions increasing (23), referrals from primary care have been recognised as a factor driving high demand for imaging services (15). This PhD started in 2019 when the norm for obtaining an USS was to refer into the radiology department to undergo the procedure. It is recognised that throughout the duration of this PhD that the use of ‘point of care ultrasound’, where the USS is performed within the consultation, has increased (24).

A systematic review and meta-analysis investigated the rates of imaging worldwide for LBP between 1995-2015 and found that the rate of complex imaging (CT or MRI scan) has increased by 50% for those attending either primary care or the emergency department (25). Almost 25 percent (24.8%) of patients attending primary care in this time received diagnostic imaging with this rising to 35.6% of those seen in the emergency department (25). These figures relate to primary studies undertaken in North America, Australia, New Zealand, Europe, and the UK. Similar figures and higher are seen in low-middle income settings with as many as 100% of patients with persistent LBP undergoing imaging in India (26) and 70% of patients with acute LBP undergoing imaging in Brazil (27). The reasons for these differences are unclear.

In 2004 it was reported that in the UK, 20% of people presenting with LBP will undergo diagnostic imaging as part of their care episode (28,29). Whilst more recent data is not available describing the current imaging rates for LBP in the UK, when compared to similarly matched high-income settings such as Norway (2012) or the USA (2015), the rates are 38.9% (30) and 53.7% (31) respectively.

Despite the 50% increase in complex imaging for LBP seen worldwide between 1995-2015, with 24.8% of patients being seen in primary care undergoing imaging for LBP, it is important to consider whether such an increase informs treatment selection that can improve clinical outcomes. In those presenting with acute or sub-acute LBP in primary care, a systematic review of randomised controlled trials (RCT) with meta-analysis did not demonstrate any statistically significant

difference between those who received usual care with routine imaging (x-ray, MRI or CT) compared with those who received usual care without imaging (32). There were no differences reported with regards to pain, function, or quality of life at any time point up to 12-months, resulting in a pooled estimate for pain of 0.19 (95% CI; -0.01 to 0.39); negative standardised mean difference favouring imaging) and for function of 0.11 (-0.29 to 0.50) for short term outcomes (up to 3-months). However, for long term outcomes (6-12 months), a pooled estimate of 0.04 (-0.15 to 0.07) for pain and 0.01 (-0.17 to 0.19) for function. The confidence intervals crossing zero would suggest that there is insufficient evidence to conclude one way or the other regarding whether the addition of imaging to routine care improved outcomes.

A more recent (2015) prospective cohort study of 5329 patients presenting in primary care within the USA with a new episode of LBP (33) aligned with the findings of the review described above (32). This cohort study reported that those who underwent imaging (x-ray or MRI) within six weeks of their initial presentation for LBP did not differ in terms of clinical outcomes at one-year when compared to those who did not undergo imaging (33). Those who underwent imaging did not significantly differ at baseline when compared to those who did not undergo imaging for any characteristic such as socioeconomic background, pain duration, or pain severity.

Given the increased prevalence of LBP and subsequent increased burden of ill health, most of the literature investigating the role of diagnostic imaging and its utility

has been centred around this clinical condition (34,35). Despite this, there are examples in the literature that demonstrate the uncertainty surrounding the role of diagnostic imaging in those with knee and shoulder pain (36–38).

Karel et al. (36) undertook a systematic review investigating the effect of routine diagnostic imaging for patients with MSK conditions. The aim of this review was to determine whether diagnostic imaging following initial assessment influenced subsequent clinical outcomes. The review was not limited by MSK condition or body site, rather attempting to build on the systematic review described above (32) that focused on LBP, and only included RCTs. Eleven RCTs (2777 patients) were included in the review with seven including a sample with acute or sub-acute LBP (three conducted within the UK) and four including a sample with knee pain (all conducted within the UK).

The results of this systematic review demonstrated that there was a small effect in both the short term (Standardised Mean Difference (SMD) 0.17; 95% Confidence Interval (95%CI) 0.04-0.31) and long term (SMD 0.13; 0.02-0.24) with regards to pain intensity, in favour of not routinely imaging for those with LBP. This is a different result to the original review (32) and may be explained by the addition of new trials that had been published in the intervening period. Whilst for knee pain, no statistically significant difference was demonstrated regarding pain intensity. There was no statistically significant difference ($p > 0.05$) between routinely imaging and not routinely imaging in either the short or long term when evaluating function (both with generic and disease specific instruments), quality of life, or

patient satisfaction. The results further suggest that routine imaging for those with LBP and knee pain does not necessarily translate into improved clinical outcome.

It has been reported that up to 43% of asymptomatic people have features of osteoarthritis (OA) on knee MRI (37). OA is a clinical diagnosis however, in the context of a high prevalence of radiological features in the asymptomatic population, it is difficult to determine the relevance of these findings when someone presents clinically with knee pain. In a retrospective review of 680 patients who attended a specialist knee clinic in South Korea over a 6-month period, 185 (27%) were referred with an MRI obtained in primary care prior to referral, the majority for non-traumatic knee pain (38). The utility of each MRI was assessed in terms of how useful the results were to informing diagnosis and subsequent treatment and classified as useful, equivocal, and arguably useless. 'Useful' related to playing a crucial role in making the correct diagnosis and subsequent treatment selection; 'equivocal' related to potentially playing a useful role; and 'arguably useless'; related to playing minimal or no role. The utility assessment was performed by a panel of five Orthopaedic surgeons. The results demonstrated that 35 (18%) were classified as equivocal and 77 (43%) were classified as 'arguably useless'. Within the limitations of a retrospective review (e.g. the subsequent treatment provided and outcome obtained being known at the time of utility assessment) this study would suggest that MRI might be overused in those with knee pain. This study suggests that optimising the use of imaging is required in those with peripheral presentations, and not just for those with LBP.

A similar study has been conducted in those presenting with non-traumatic shoulder pain to a specialist shoulder clinic in the USA (39). A retrospective review of 101 consecutive new patients (104 symptomatic shoulders) referred from primary care reported that 43 (41%) symptomatic shoulders had undergone an MRI prior to referral. The authors sought to determine whether there was any difference in clinical presentation, and subsequent outcome, for those that had an MRI of their shoulder pre-referral, compared to those that did not have an MRI. Following initial assessment, there were no statistically significant differences ($p > 0.05$) with regards to prior treatment, suspected clinical diagnosis, symptom duration, range of motion, visual analogue scale (VAS) or the Simple Shoulder Test (a patient reported outcome measure specific to shoulder function). Further, there was no statistically significant difference regarding subsequent treatment received (surgery or physiotherapy) or clinical outcomes at 6-months following blinded assessment. Of the 61 patients that did not have an MRI prior to referral, 10 subsequently had an MRI following initial assessment. With no differences in clinical presentation or subsequent outcome between those who were referred with or without an MRI scan, this study would suggest that the clinical use of MRI by non-specialist, primary care clinicians in those with non-traumatic shoulder pain is not aligned to clear indications or thresholds. This should however be considered in the context of its limitations which included a limited follow up period, as well as a lack of power. A power analysis conducted by the authors indicated that 450 patients would be needed for 80% power, and as such the 101 patients included is small, and questions the validity of the findings.

Whilst no clear difference is observed in relation to clinical outcomes, the problems associated with the risk of misuse of diagnostic imaging are well recognised. A potential waste of finite healthcare resources has a clear economic consequence on a societal level, whilst on a patient level, early use of diagnostic imaging and in particular MRI for LBP has been shown to risk greater fear avoidance beliefs, catastrophisation, poorer perceived prognosis, greater work absenteeism, longer length of disability, and an increased chance of undergoing spinal surgery (40–42). Regarding other imaging modalities, such as x-ray or CT, there is the exposure to unnecessary radiation that has the potential to promote carcinogenesis (43).

Despite the increase demand for and use of imaging in primary and intermediate care, there is uncertainty and an inconsistent association between imaging findings, symptoms, and treatment outcomes for those with LBP, knee and shoulder pain. When this is combined with the risks associated with the overuse or inappropriate use of diagnostic imaging as well as the potential impact this has on patient outcomes, there is a need to better understand the rationale for, and decision making behind the use of diagnostic imaging to enable more appropriate requesting and reduce waste.

1.3 Theoretical Perspective

In the context of this thesis where the overarching research question was outlined a priori as part of the ACORN funded studentship from Keele University, my theoretical perspective relates to the refinement of the research question and the methods utilised to answer. Pragmatism is pluralistic, ontologically viewing reality as both singular and multiple and epistemologically considering practicality, with a

focus on ‘what works’ most effectively (44,45). In pragmatism, the researcher is free to approach an investigation both deductively and inductively dependent on the question being asked and as such, both quantitative and qualitative approaches can be undertaken within the same study (45). Given this freedom, pragmatism is the dominant worldview that underpins mixed - or multi-methods research. Multi-methods research is where two or more different methods are used within the same study or programme of research (46). In essence, multi-methods research refers to the use of different methods to address different parts of the same question (46,47). Within this thesis there is an overarching aim with different objectives, aligning to a multi-methods approach being the most suitable to use (46,47).

1.4 Thesis Aims and Objectives

The aim of this PhD is to better understand the reasons for requesting imaging for patients with common MSK pain conditions, including lower back, knee, and shoulder pain. A secondary aim is to understand how the imaging findings are used; from the perspective of both the patient and clinician, including how such information might guide treatment and referral for further clinical opinion.

Underpinning these aims are several objectives:

i. To review clinical practice guidelines (CPGs) to understand current recommendations for requesting diagnostic imaging in adults.
ii. To review publicly available web platforms to understand the current information available to patients about the use of diagnostic imaging in adults.

iii. To undertake qualitative interviews with adult patients and clinicians to understand why diagnostic imaging is requested, and how the findings are used within clinical practice from the dual perspective.

iv. To propose recommendations for clinical practice, research, and policy related to the requesting and use of diagnostic imaging for common MSK pain conditions in adults.

Through achieving these objectives, it is suggested that knowledge will be advanced in terms of understanding why imaging is requested, and recommendations for how the findings are used within clinical practice.

To achieve these aims and objectives, the PhD is structured in three phases.

Phase 1

This phase enables the achievement of the primary aim. Within this first phase, two scoping reviews have been completed. The first scoping review investigates the recommendations for imaging use from CPGs (Chapter 2). The second scoping review investigates the recommendations for imaging using contained within public-facing websites (Chapter 3).

Phase 2

This phase enables the achievement of both the primary and secondary aims. Within this second phase, two qualitative investigations have been completed (background and methods of both are presented in Chapter 4). The first qualitative investigation explores the use of diagnostic imaging from the perspective of the patient (findings and discussion of patient interviews/perspective in Chapter 5). The second qualitative investigation explores the use of diagnostic imaging from the

perspective of the referring clinician (findings and discussion of clinician interviews/perspective in Chapter 6).

Phase 3

This phase enables the achievement of both the primary and secondary aims. Within the third phase, the findings from both scoping reviews and both qualitative investigations are considered in the form of an overall discussion, conclusions and recommendations for clinical practice, research, and policy (Chapter 7).

This chapter set the scene for this PhD thesis by providing the background context, theoretical perspective, aims and objectives. In the next chapter, the first scoping review of this thesis will be presented.

Chapter 2: Scoping Review of Clinical Practice Guidelines

Based upon Cuff et al. (2020). Guidelines for the use of diagnostic imaging in MSK pain conditions affecting the lower back, knee and shoulder: A scoping review. MSK Care, 18 (4), 546-554 (Appendix 1)

Summary

This chapter presents the first of two scoping reviews. The first scoping review retrieved clinical practice guidelines (CPGs) and reports their recommendations relating to the use of diagnostic imaging. The findings of this review provide context to the thesis and insight into the best available evidence to guide imaging use in primary and intermediary care.

2.0 Background

The purpose of this scoping review was to fulfil objective **i** (**see 1.4)** of this thesis; to review clinical practice guidelines (CPGs) to understand current recommendations for requesting diagnostic imaging in adults. CPGs have been developed to improve the quality of care delivered for those with common MSK conditions and are considered one of the key efforts to improve healthcare (48). CPGs are defined as 'statements that include recommendations intended to optimise patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options' (49)

To better understand the rationale for, and decision making behind the use of diagnostic imaging there is a need to first identify and map the content of CPGs that are relevant to UK clinical practice in primary and intermediate care with respect to the use of diagnostic imaging for adults with non-traumatic MSK pain conditions affecting the lower back, knee and shoulder. In doing so, this will provide insight into what the best available evidence recommends regarding the use of diagnostic imaging.

Objectives of this review

- To identify existing CPGs that inform MSK/Orthopaedic clinical practice in the UK in relation to the use of diagnostic imaging (X-ray, MRI, USS) in those with non-traumatic LBP, knee, and shoulder pain.

- To describe and summarise recommendations from CPGs that inform MSK/Orthopaedic clinical practice in the UK on the use of diagnostic imaging in those with LBP, knee, and shoulder pain.

- To identify similarities and differences across CPG recommendations.

2.1 Methods

2.1.1 Design

The aim of this scoping review was to identify and map the content of CPGs that are relevant to UK clinical practice in primary and intermediate care with respect to

the use of diagnostic imaging for adults with non-traumatic MSK pain conditions affecting the lower back, knee, and shoulder.

Whilst both scoping reviews and systematic reviews aim to ensure validity of their results through clear and rigorous methods, the difference between the two methods relates to the purpose for which they are conducted. Whilst the general purpose of a scoping review is to identify and map, in contrast, a systematic review is undertaken with a narrower focus and may have been preceded by a scoping review (50). A scoping review enables examination and charting of a broad topic area to clarify key concepts that inform practice (51) with the overall objective being to identify and map the existing evidence (52). As such, a scoping review is the ideal method to achieve the aim and determine the coverage related to recommendations on the use of diagnostic imaging within CPGs as well as providing a summary of those recommendations (50).

This scoping review was designed with reference to guidance described by the Joanna Briggs Institute (JBI) (53,54) and is further informed by guidance from Tricco et al. (55). The JBI is a collaboration that aims to improve global health through the promotion of, and supporting the use of, the best available evidence to inform clinical decisions. With the number of scoping reviews being published increasing (56) there were concerns regarding both the methodological quality of scoping reviews, as well as the reporting quality (56). To improve reporting quality and to ensure that it was both transparent and complete, an extension to existing PRISMA guidance was published to provide guidance on preferred reporting items

for scoping reviews (55). This PRISMA extension for scoping reviews was developed with reference to the guidance document produced by the Joanna Briggs Institute (53,54).

The protocol for this scoping review was agreed a priori and can be found in **Appendix 2**. An attempt to register the protocol with PROSPERO was declined; the reason cited was that PROSPERO did not publish scoping review protocols at the time.

The following inclusion criteria were used to determine which CPGs to include within this review (Tables 1 and 2):

Table 1: Inclusion Criteria

Inclusion Criteria	**Justification**
CPGs either developed in the UK or CPGs intended for wider regional use (e.g., continental or international CPGs) that inform MSK/orthopaedic UK clinical practice within primary or intermediate care for adults with non-traumatic LBP, knee and shoulder pain.	This scoping review forms part of a wider research programme and will form the basis of a future qualitative investigation of UK-based clinicians and patients. Given that this qualitative research will be undertaken in the UK and be focused on UK clinical practice, this forms the focus of the review. It is in turn logical to refer to UK-related guidance given health care systems are different in different countries. To achieve this, CPGs will be included if they are developed in the UK. CPGs will also be included if a continental or international body that represent UK-based clinicians or specialist interest group. An example of this would be CPGs produced by the European League Against Rheumatism (EULAR) where the British Society of Rheumatology (BSR) represents the UK as scientific member society.

	One of the objectives of this review is to identify existing CPGs. A systematic review process must be described to meet the definition of a CPG. A scoping review allows for the mapping and collation of existing evidence whilst identifying gaps and being able to provide future directions. The presence/absence of a development process will be considered within the data charting and subsequent reporting (51). Intermediate care is defined as services within a care setting that do not require the resources of a general hospital but deliver a scope beyond that of a traditional primary care service (57)
CPGs that provide recommendations on the use of diagnostic imaging in adults with non-traumatic LBP, knee and shoulder pain.	The focus of this review is on the lower back, knee and shoulder. This focus stems from epidemiological evidence of the prevalence of these MSK pain presentations; they represent the most common body sites for MSK pain in the upper limb, lower limb and spine, respectively (5,6). This will provide opportunity to compare and contrast between the most researched area of LBP and the lesser researched upper limb and lower limb. Non-traumatic is defined as pain that is MSK in origin in the absence of a single definable incident of sufficient velocity or force to invoke tissue injury such as a fracture or dislocation.
CPGs that are finalised and published within a date limit 2009-2019.	A date limit of the last 10 years was decided with reference to the known literature. This was decided to ensure that included CPGs are contemporary and therefore appropriate to inform current practice. Necessarily, this cut-off is somewhat arbitrary.
CPGs that are: - accessible in the public domain - accessible via publication or internet searches - accessible via recognised professional bodies or societies.	To ensure that the review is representative of clinical practice, the sources identified need to reflect those that can be accessed readily by clinicians. CPGs that are accessible in the public domain via publication, internet searches or recognised professional bodies/societies are the typical access routes for clinicians and as such both the inclusion criteria and subsequent search strategy reflect this.

Table 2: Exclusion Criteria

Criteria	Justification
CPGs that are not focused on adult populations (less than 18-years).	The focus of this scoping review is adults that present with LBP, knee or shoulder pain.
CPGs or clinical pathways developed by Clinical Commissioning Groups (CCGs) for local implementation only.	The focus of this review is CPGs that have been developed and informed following a systematic review of the evidence that are accessible and relevant to all clinicians within UK practice.
Indications for the use of diagnostic imaging to evaluate the risk of fragility fractures, including the use of Dual Energy X-ray Assessment (DEXA) scanning to determine bone mineral density (BMD).	The focus of this review is on diagnostic imaging for those with LBP, knee or shoulder pain. Whilst indications for assessment of fragility fracture such as major osteoporotic fractures (clinical vertebral and shoulder fractures) are included, the use of DEXA within clinical practice is often for the prediction of future fracture in those with clinical risk factors for low BMD, or those that have previously sustained fragility fracture (Ralston et al. 2015).

2.1.2 Search Strategy

A comprehensive search strategy was developed in accordance with guidance for conducting a scoping review (53). An initial search strategy was drafted using key words and then refined using the Medical Subject Headings and the National Library of Medicine with support from a health sciences librarian. Search terms were deliberately broad to ensure that the search was comprehensive allowing all relevant CPGs to be identified.

The search terms (**Appendix 2**) were combined using Boolean logic and were used to perform searches of the identified key databases (MEDLINE, CINAHL complete, PsycINFO and SPORTDiscus) from 2009 to the 17th April 2019.

A search of guideline repositories was also conducted to complement the search of scientific databases; the National Institute for Health and Care Excellence (NICE); Guidelines International Network (GIN) and Guidelines (a UK-based repository of clinical guidelines for primary care). The search terms for these repositories are outlined in **Appendix 2.**

Alongside the systematic search detailed above, a 'snowball' search was also undertaken to identify any published CPGs that met the inclusion criteria that may have been missed by the search of scientific databases and guideline repositories. A 'snowball' search is a method that has been demonstrated to be an effective way of finding and obtaining sources of information, in this instance CPGs, that may be stored in non-traditional locations which formal search strategies of scientific databases may not identify (58). As CPGs are not considered to be research evidence rather, they should be informed by research evidence, they may not be indexed within scientific databases (59).

In the snowball search, the terms described in Table 3 were entered into a Google search (60) and the top 50 results were assessed. To complete the 'snowball' search the websites of the following professional bodies that are relevant to primary care MSK clinical practice were also searched: Royal College of General Practitioners (RCGP), Royal College of Radiologists (RCR), Chartered Society of Physiotherapy (CSP), Primary Care Rheumatology Society (PCR) and the British Association of Sport and Exercise Medicine (BASEM).

Table 3: This table outlines the search terms used within the 'snowball' search.

Knee Pain Guidelines
Shoulder Pain Guidelines
Low Back Pain Guidelines

A request for CPGs that meet the inclusion criteria was circulated through the following clinical networks: Advanced Practice Physiotherapy Network (APPN); RCGP; RCR; CSP; PCR; BASEM.

Previous scoping reviews (60) have demonstrated how the use of novel social media can complement a search strategy to increase the reach and totality of a search. As such, the following message was distributed on Twitter and promoted for 14 days (60) from the 17th April 2019 to the 1st May 2019 with responses to the message reviewed for relevance.

"Please help with my PhD research by sharing any clinical practice guidelines that indicate when to order #diagnostic #imaging for #knee, #shoulder or #LBP. Retweets appreciated. Thank you."

2.1.3 Study Selection

All titles identified by the search were read by one reviewer (AC) and duplicates were removed using Mendeley reference management software. Any obviously irrelevant hits were removed at this stage. Two reviewers (AC and RT)

independently conducted a pilot evaluation of the inclusion and exclusion criteria on ten of the remaining hits and no modifications were required; a third member of the review team (primary academic supervisor) arbitrated in the event of any disagreement. RT is an experienced, Advanced Practice Physiotherapist who supported the conduct of this scoping review by acting as the second reviewer.

If abstracts were available, they were reviewed independently by two reviewers (AC and RT) who applied the inclusion/exclusion criteria. A third member of the review team (primary academic supervisor) arbitrated in the event of disagreement. Where a decision could not be made on eligibility from the abstract, or if an abstract for the CPG was not available, the full CPG document was obtained. Conference abstracts or summaries of CPGs presented within conference listings were not excluded initially. If such abstracts/summaries were identified within the search, attempts were made and documented to obtain a full copy of the CPG. If a full copy of the CPG could not be obtained, then it was excluded.

Full CPG documents were reviewed independently by two reviewers (AC and RT) who applied the inclusion/exclusion criteria. A third member of the review team (primary academic supervisor) arbitrated in the event of disagreement.

To be confirmed as a CPG, it had to be evident that a systematic review process had been undertaken as part of its development. A systematic review refers to a review of the literature that is undertaken according to a defined and systematic

approach incorporating explicit rigorous methods of searching, critiquing, and synthesising the underpinning evidence; in contrast, a literature review incorporates undefined methods of searching, critiquing, and synthesising the evidence which can be associated with a higher risk of bias (61). If it was not clear whether a systematic review had been undertaken as part of the guideline development process, then the producing organisation (or authors if there is no producing organisation) were contacted for further information. If a systematic review was not undertaken or undertaken but not then used to inform the development of the CPG or there was no response received to the request for further information, then the document was excluded.

To complete the search strategy, the reference list of all CPGs where a full CPG document has been obtained was hand searched by one reviewer (AC).

2.1.4 Quality Appraisal

CPGs that had undertaken a systematic review, but where the development process was not clearly reported, were included in the review as one of the objectives was to identify all relevant existing CPGs. The presence/absence of a development process is considered within the data charting and subsequent reporting.

Formal appraisal of methodological quality is generally not performed in scoping reviews and is regarded as optional (53). Given the overarching aim of this review

is to identify and map the content of CPGs that are relevant to UK clinical practice with respect to the use of diagnostic imaging, rather than the full CPG, for those with LBP, knee and shoulder pain, a full assessment of methodological quality was not necessary. However, to provide context to the reporting, an assessment of the rigour of the development process was performed through a modification of the Appraisal of Guidelines for Research and Evaluation (AGREE) II tool. The AGREE II tool has been demonstrated to be a valid and reliable appraisal instrument for CPGs and is the most utilised tool for this purpose. (62–64)

All included CPGs were appraised using the third domain of the AGREE II tool 'Rigour of Development'; the AGREE II tool does not provide cut off scores for whether a CPG is high or low quality however, previous reviews have utilised this domain as an important indicator of CPG quality. If a CPG scores equal to, or higher than 50% then the CPG was deemed high quality. This cut-off was adopted in keeping with other published reviews and was adopted with recognised limitations of an arbitrary cut-off point (65).

Each CPG was appraised by one reviewer (AC) and verified by a second reviewer (RT); to ensure familiarity with the tool, both reviewers completed the two training exercises available via the AGREE II website (66)). Initially each CPG was appraised using the 'Rigour of Development' domain. This domain consists of eight criteria evaluating the process used to develop the CPG, each criterion is scored between 1 (low rigour) and 7 (high rigour) with a maximum score of 56 equating to 100% for developmental rigour. Once each criterion had been

considered and a score provided for each CPG, this was sent to the second reviewer for verification. A third member of the review team (primary academic supervisor) arbitrated in the event of disagreement.

2.1.5 Charting the results (Data Extraction)

The relevant characteristics of the included CPGs and the key data relevant to the review aims and objectives were recorded in a charting table in **Appendices 3-6**.

Data extraction was independently trialled by two reviewers (AC and RT) on five included CPGs to assess the suitability and capacity to chart all relevant information required to answer the research objectives. If changes were required, these were agreed upon by both reviewers and implemented. A third member of the review team (primary academic supervisor) arbitrated in the event of disagreement. Changes from the protocol included the removal of the columns titled ‘development process’ and ‘concept e.g. imaging modality’ as it was felt the final column titled ‘key findings’ was sufficient to capture this detail.

One reviewer (AC) was responsible for charting the results and these were verified by a second reviewer (RT); A third member of the review team (primary academic supervisor) arbitrated in the event of disagreement.

When all results were charted, a narrative synthesis was undertaken to provide an overview of recommendations for the use of diagnostic imaging for those with

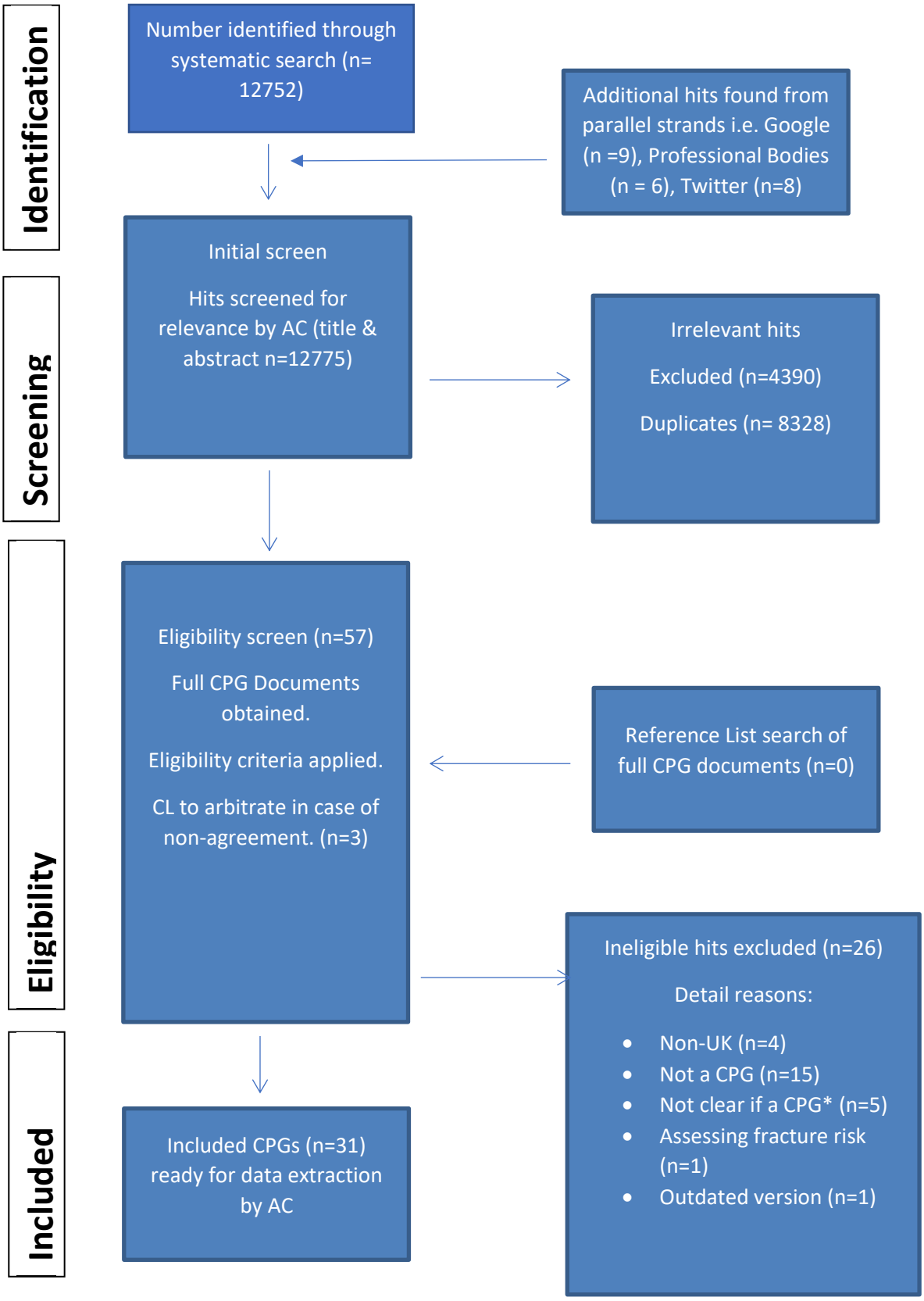
LBP, knee, and shoulder pain. A narrative synthesis refers to the process of combining, outlining, and summarising the recommendations from multiple CPGs via a textual approach (67). Through this synthesis, similarities and differences across the CPGs were identified. This synthesis was verified by a second review (RT). A third member of the review team (primary academic supervisor) arbitrated in the event of disagreement.

2.2 Results

2.2.1 Study Selection

A total of 12,775 hits were identified through the search strategies. Following the study selection process, 57 full text documents were obtained. 31 CPGs met the inclusion criteria (**Table 4**). 26 citations were excluded at this stage and the reasons for exclusion are outlined in brief within **Figure 3** with further detail provided in **Appendix 7.**

Figure 2. Flowchart outlining the selection process for Clinical Practice Guideline (CPG) inclusion within the scoping review of CPGs.



*Where it was not clear whether a systematic review had been conducted as part of the CPG development process (in order to meet the definition of a CPG) authors were contacted, if no reply was received, this hit was excluded.

Table 4: Overview of CPGs included within the scoping review.

Authors	Year	Development Group e.g., NICE	Body site/regional condition	Origin
Ward et al. (68)	2016	National Institute for Health and Care Excellence (NICE)	LBP	UK
NICE Clinical Knowledge Summary (CKS) – LBP (69)	2018	NICE	LBP	UK
NICE CKS – Sciatica (70)	2018	NICE	LBP	UK
NICE CKS – Ankylosing Spondylitis (AS) (71)	2013	NICE	LBP	UK
White et al.(72)	2014	NICE	LBP	UK
Zhang et al. (73)	2010	European League Against Rheumatism (EULAR)	Knee Pain	Europe
Price et al. (74)	2017	British Orthopaedic Association (BOA)	Knee Pain	UK
Sakellariou et al. (75)	2017	EULAR	Knee Pain	Europe
Fernandes et al. (76)	2017	EULAR	Knee Pain	Europe
Crossley et al. (77)	2016	Patellofemoral Pain Research Retreat	Knee Pain	International
Barton et al. (78)	2015	N/A	Knee Pain	International
McAlindon et al.	2014	Osteoarthritis Research Society International (OARSI)	Knee Pain	International
NICE CKS (79)	2017	NICE	Knee Pain	UK
Hanchard et al. (80)	2011	Chartered Society of Physiotherapy (CSP)	Shoulder Pain	UK
Dejaco et al.	2015	EULAR	Shoulder Pain	Europe
NICE CKS (81)	2017	NICE	Shoulder Pain	UK
Compston et al. (82)	2017	National Osteoporosis Guideline Group	Osteoporosis	UK
Ralston et al. (83)	2015	Scottish International Guidelines Network (SIGN)	Osteoporosis	UK
Lems et al. (84)	2016	EULAR	Osteoporosis	Europe

McVeigh et al. (85)	2017	NICE	Spondyloarthropathy (SpA)	UK
Mandl et al. (86)	2015	EULAR	SpA	Europe
NICE CKS (10)	2018	NICE	Osteoarthritis (OA)	UK
Conaghan et al. (87)	2014	NICE	OA	UK
Ward et al. (88)	2018	NICE	Rheumatoid Arthritis (RA)	UK
Colebatch et al. (89)	2013	EULAR	RA	Europe
Richette et al. (90)	2016	EULAR	Gout	Europe
Richette et al. (91)	2018	EULAR	Gout	Europe
Hui et al. (92)	2017	British Society of Rheumatology (BSR)	Gout	UK
Hajioff et al. (93)	2015	NICE	Malignancy	UK
Ralston et al. (94)	2019	Paget's Association UK	Paget's Disease	UK
Remedios et al. (95)	2017	The Royal College of Radiologists (RCR)	Miscellaneous	UK

2.2.2 CPG Origin

The focus of this scoping review was to map the CPGs that were relevant to UK clinical practice. Relevant in this context refers to being developed for implementation within UK clinical pathways or being developed with the intent to being implemented across international pathways. The majority of included CPGs were developed in the UK (n = 19), followed by development as part of a continental (European) workforce (n = 9) and international workforce development (n = 3).

2.2.3 Regional MSK Condition

The clinical focus of the review was for those presenting within primary or intermediate care with non-traumatic LBP, knee or shoulder pain. The included CPGs were equally divided between those for a specific MSK presentation (n = 16) with LBP (n=5), knee (n=8) and shoulder pain (n=3) and those for a regional condition that has the potential to present as LBP, knee or shoulder pain (n = 15).

2.2.4 CPG Rigour of Development

The majority (27/31) of the included CPGs were deemed to be of high quality **(Appendix 3 – 6)**; the common areas of guideline development lacking rigour were balancing the benefits of recommendations alongside risks, harms or side effects; undergoing an external consultation period for stakeholder input and providing clarity on any intended updates **(Appendix 8).**

2.2.5 Recommendations on the use of diagnostic imaging in those with LBP, knee and shoulder pain.

The majority of the included CPGs made recommendations on the use of diagnostic imaging (n = 21) within primary and intermediate care. Below is a narrative synthesis of recommendations on the use of diagnostic imaging across CPGs.

Low Back Pain (68–72,82,85,86,94,95)

Routine diagnostic imaging is not recommended within primary care or intermediate care, in both non-specialist (e.g. GP Practice) and specialist (e.g. MSK Interface Clinic) settings for those with LBP. In the absence of suspected serious pathology, imaging is not recommended within non-specialist settings but rather should be reserved if red flags or serious pathology are suspected. Within a specialist setting, reserve diagnostic imaging if it is likely to change management.

The use of x-ray is explicitly discouraged in those with LBP unless a fracture or axial spondyloarthropathy (SpA) is suspected. Where there is a suspicion of axial SpA, if sacroiliitis is not demonstrated and suspicion remains, perform an MRI of the sacroiliac joints; the NICE SpA guidelines (85) also recommend the addition of a Whole Spine MRI however, the EULAR guidelines (86) do not recommend this.

Knee Pain (10,74,76–79,85–87,89,91,93–98)

The majority (n=6) of CPGs for those with knee pain relate to knee osteoarthritis (OA); those CPGs for patellofemoral pain (PFP) make no recommendations on the

use of diagnostic imaging. Knee OA is considered a clinical diagnosis based on patient age and clinical symptoms that do not require an x-ray to inform diagnosis, with routine imaging during OA follow up not recommended.

Whilst typically a clinical diagnosis, consider the use of diagnostic imaging in atypical presentations, to exclude alternative presentations e.g., gout or if there is a sudden clinical deterioration. In such circumstances an x-ray being the initial first line investigation of choice before using other modalities. If peripheral SpA or malignancy are suspected, then it is recommended to consider an USS and/or MRI.

Shoulder Pain (10,80,81,85,87,89,91,93–95,99)

Routine imaging is not recommended for those with shoulder pain. If movement is significantly restricted, symptoms are not improving or if suspecting serious pathology or bone pain then consider a two-view x-ray. USS and MRI are not recommended for those with shoulder pain unless gout or malignancy are suspected.

2.2.6 Similarities between the included CPGs

Across the CPGs included within this review, the routine use of diagnostic imaging for those with non-traumatic LBP, knee or shoulder pain is discouraged. In clinical circumstances where serious pathology is suspected, or where the person is not responding to initial conservative management and the result is expected to change management of that person's presentation then diagnostic imaging is indicated.

2.2.7 Differences between the included CPGs

Whilst there are similarities with regard to when to utilise diagnostic imaging and in what circumstances, the differences are concerned with modality and clinical setting. The use of x-ray in those with LBP is discouraged unless there is a clinical suspicion of a specific pathology i.e., fracture or Axial SpA whilst in those with knee or shoulder pain, an x-ray is encouraged as the initial investigation before USS or MRI.

There is variation across the CPGs relating to how recommendations are structured. In the main, recommendations for imaging are written without care setting or level expertise in mind. However, there are some that are written with the care setting in mind (n=3), outlining what should be considered within primary or secondary care (74,95,100). As well as a minority (n = 2) written with the level of expertise in mind e.g., non-specialist or specialist settings (68,85) as opposed to where that care episode takes place.

2.3 Discussion

The aim of this scoping review was to identify and map the content of CPGs that are relevant to UK clinical practice in primary and intermediate care with respect to the use of diagnostic imaging for adults with non-traumatic LBP, knee, and shoulder pain, fulfilling objective **i** of this thesis (**see 1.4**). To date, this represents the most up to date and comprehensive review of CPGs and recommendations for use of diagnostic imaging within these care settings. The routine use of diagnostic imaging for those with non-traumatic LBP, knee or shoulder pain is discouraged across CPGs with the recommendations for use being reserved for where serious pathology is suspected, the person is not responding to initial conservative management, or the result is expected to change management of that person's presentation.

It is important to consider the context in which the results of this review are relevant; the focus of this review related to recommendations for imaging within primary and intermediate care. For the majority of people presenting with LBP, knee or shoulder pain the recommended clinical care is non-surgical, focused on advice, education, activity modification and exercise therapy (9,10). More invasive options such as surgery are reserved for those incidences where conservative treatment has not been successful (12); the recommendations for diagnostic imaging are consistent with this approach where the findings may guide the necessary change in management.

The CPGs for LBP are consistent in that the routine use of x-ray is not recommended unless there is a suspicion of specific pathology i.e., fracture or SpA.

This differs to the recommendations within the CPGs for knee or shoulder pain; when the presentation is not clear, is not responding to conservative management or serious pathology is suspected then the use of x-ray as a first line investigation is recommended. A possible reason for this may be that the findings of an x-ray in the periphery may alter the management plan, or inform the shared decision making process to a greater extent than in the spine; a spinal fracture is usually managed for pain-relief in the absence of neurological signs with surgical options being limited (101) whilst investigating with a suspicion of SpA within primary or intermediate care is commonly undertaken alongside a referral into a specialist Rheumatology clinic. In contrast, in the periphery an x-ray may inform the decision to refer for Orthopaedic opinion for consideration of arthroplasty, or for other interventions, including hydrodistension, in the person presenting with a stiff shoulder (102).

The diagnosis of a frozen shoulder is a unique non-traumatic pain presentation whereby it is commonly considered that an x-ray must be undertaken to confirm the diagnosis. The rationale behind this being that other pathologies can mimic the presentation of a frozen shoulder and thus a ‘normal’ x-ray excludes these pathologies, in turn confirming the diagnosis of frozen shoulder (102). This approach to clinical practice of routine imaging for those presenting with a painful, stiff shoulder is at odds with the general recommendations across CPGs of not routinely using diagnostic imaging and has also been challenged in the wider literature (103).

Some of the known masquerades for a frozen shoulder include avascular necrosis and malignancy; it is known that for these two disease processes to be detected on

x-ray that they must be quite advanced and in turn a ‘normal’ x-ray may not necessarily confirm the diagnosis of a frozen shoulder as intended. A greater challenge to this practice, particularly in the context of primary and intermediate care, manifested within a published service evaluation of a UK-based, MSK service. This service evaluation demonstrated that in the 350 x-rays performed over a 42-month period when there was a clinical suspicion of frozen shoulder, 2.3% (n = 8) demonstrated a different pathology; six were severe OA, one a tumour in a patient with a history of malignancy and one a fracture in a patient with a history of trauma (103). When considering that the primary care management of a patient with frozen shoulder and glenohumeral joint OA are the same, typically involving education, analgesia and an intra-articular steroid injection (104),this paper challenges the requirement for routine x-ray within primary care to inform the diagnosis of a frozen shoulder but rather supports a more reasoned approach to diagnostic imaging use that is consistent with CPG recommendations.

Whilst the results of this scoping review refer to recommendations across CPGs related the use of diagnostic imaging in UK-clinical practice within primary and intermediate care, these are similar to the findings of those demonstrated by Lin et al. (2019) in a systematic review of high-quality international CPGs (9). This systematic review aimed to identify a core set of recommendations for assessment and management that were common across a wide range of MSK pain conditions, derived from CPGs. The MSK pain conditions of focus included lumbar, thoracic, cervical, hip, knee and shoulder pain.

Lin et al. (2019) recommended that radiological imaging was discouraged unless serious pathology is suspected; there has been unsatisfactory response to conservative care or unexplained progression of signs and symptoms; it is likely to change management. Within this review by Lin et al. (2019), recommendations did not focus on a particular care setting or country of practice and excluded specific diseases processes e.g., osteoporosis, malignancy, rheumatological conditions and frozen shoulder. The inclusion of regional MSK conditions within this scoping review that may present as LBP, knee or shoulder pain adds to the knowledge base as it highlights a level of consistency regarding recommendations for the use of diagnostic imaging across clinical populations.

This review included 31 CPGs that were published between 2009 and 2019. 26 hits returned by the search were excluded, with 18 either due to not fulfilling the definition of a CPG (n=12) or, being unable to determine whether the definition or criteria had been fulfilled (n=6). In most circumstances, this related to the absence of an initial systematic review being undertaken as part of the CPG development process.

The NICE accreditation programme appraises the processes used to develop a CPG with the aim of raising CPG development standards, ensuring high-quality processes are utilised, high-quality information disseminated to clinicians and in turn to increase the chances that the guideline is used to improve patient outcomes. The presence of the accreditation award is intended to identify the most trusted sources of CPGs that have been developed (105). Of note was the exclusion of Kulkarni et al. (2015) which had associated NICE accreditation (106). The reason for exclusion was due to

the systematic review upon which the CPG was supposed to be based was undertaken in 2009, and seemingly independent of the CPG process. Therefore, whilst this means that the publication does not meet the definition of a CPG and is excluded from the review, the wider implication is that the recommendations made may not be based on the most contemporary evidence.

This raises two issues; the first questioning the utility of the NICE accreditation programme as a mark of quality and the second that this publication provides a substantial amount of the information upon which the NICE CKS for shoulder pain (107) is based, which has been included within this scoping review. In turn, it is not clear whether the recommendations made within the CKS are founded on the best available, contemporary evidence which may impact on clinical decisions and subsequent patient outcomes.

The recommendations within the CPGs varied with regard to how their recommendations were stratified, either by care setting i.e. primary care, intermediate care or by level of expertise i.e. non-specialist settings, specialist settings. Historically, primary care was considered a non-specialist setting that would undertake an initial assessment and refer the patient to the relevant specialist setting that was based in secondary care (108). In recent years, this approach to pathway design and service delivery has changed with specialist services being delivering outside of secondary care settings and into the community, a change that has been further reinforced within the NHS Long Term Plan (109). Future CPGs should

consider this within the development process to aid implementation of the CPG into practice.

2.3.1 Strengths and limitations

To date, this represents the most up to date and comprehensive review of CPGs and recommendations for use of diagnostic imaging within UK primary and intermediate care settings. The strengths of this scoping review include conduct in accordance with good practice as recommended for the conduct of scoping reviews (53). Previous scoping reviews (60) have demonstrated how the use of novel social media can complement a search strategy to increase the reach and totality of a search. Using Twitter impressions can act as a measure of reach within those using Twitter as a means of Continuing Professional Development (CPD). Within the 14-days that the tweet involved within the search strategy was live, the analytics demonstrate that it was retweeted by 73 people and that 21,375 twitter uses saw the tweet. The inclusion of the tweet as part of the search strategy identified 8 additional hits that were not identified from the more traditional means of searching, two of which were included within the review. This further demonstrates that the inclusion of twitter within a search strategy offers a pragmatic, accessible and low-cost method of increasing the reach and totality of a search.

The results of this scoping review must be considered with respect to its limitations. The inclusion criteria for this review were strict in respect that only CPGs were reviewed, and only those citations that satisfied the definition of a CPG were included. This means that resources that clinicians may use to guide their clinical

practice, including those that may be described as a ‘guideline’ without satisfying the criteria for a CPG, may have been excluded. The focus of this review was also limited to UK practice which limits the generalisation of the findings however, it must be considered that the findings are similar to a review of international CPGs (9).

2.4 Conclusion of this review

The routine use of diagnostic imaging for those with non-traumatic LBP, knee or shoulder pain is discouraged. Diagnostic imaging within a primary care or intermediate care setting within UK practice should be reserved for cases where:

- specific pathology is suspected or;
- serious pathology is suspected or;
- where the person is not responding to initial non-surgical management and the result is expected to change clinical management of that person’s presentation.

This chapter presented the first of two scoping reviews. This scoping review summarised the recommendations within CPGs related to the use of diagnostic imaging. In the next chapter, the second scoping review is presented. This scoping review evaluated written information relating to the use of diagnostic imaging from publicly available websites.

Chapter 3: Scoping Review of public-facing websites

Based upon Cuff et al. (2022). Recommendations on public-facing websites regarding diagnostic imaging for low back, knee, and shoulder pain: A scoping review. PEC Innovation, 1, 100040, 1-11. (Appendix 9)

Summary

This chapter presents the second scoping review of this thesis. This scoping review retrieved and evaluated written information relating to the use of diagnostic imaging from publicly available websites. The findings of this review provide further context to the thesis, building on that outlined in the previous chapter.

3.0 Background

The purpose of this scoping review was to fulfil objective **ii** (**see 1.4)** of this thesis; to review publicly available web platforms to understand the current information available to patients about the use of diagnostic imaging in adults. Between 2011/12 and 2016/17 there has been a 16% increase in the use of diagnostic imaging within the National Health Service (NHS) in England with the high demand from primary care being acknowledged as a challenge (15). Within this challenge, patient expectations about diagnostic imaging have been suggested to be one factor that might explain the rise in imaging requests (15,110). These expectations include the use of imaging to inform a diagnosis, and in turn inform management options, as well as to legitimise their presenting complaint (110).

The NHS Long Term Plan (109) outlines how, within the NHS, patients will have more control over their own health and more individualised care. To achieve this, the need for a fundamental shift in how clinicians work alongside patients is outlined, a model referred to as patient-centred care. Within a patient-centred care model, the encounter between the clinician and the patient is considered an equal encounter whereby the patient is an active partner, with the patient-clinician relationship being one of interdependence. The dialogue within the consultation is bidirectional, ensuring that the perspective of the patient is understood and considered (111). This contrasts with a paternalistic relationship where the power sits with the clinician, and the patient is a passive recipient of care, as has previously been the prevailing model in healthcare (112).

Underpinning such a model of healthcare is the notion of 'shared decision making' (SDM). SDM has been defined as "an approach where clinicians and patients share the best available evidence when faced with the task of making decisions, and where patients are supported to consider options, to achieve informed preferences" ((113). This involves the patient and the clinician reaching a decision regarding healthcare collaboratively having discussed available options, associated risks and benefits alongside the expectations, values and preferences of the patient (114).

It has been recognised that the beliefs and expectations of the patients with MSK pain conditions can influence their clinical outcomes such as pain and function (115,116) and that patients are increasingly using the internet as a resource for obtaining information about health conditions and healthcare (117). Unlike more

traditional forms of media, the internet is not under universal editorial control and those uploading content are able to influence their standing through marketing and paid advertisements. Whilst some sources of health information on the internet will be subject to independent review, as with research publications, this does not ensure their quality. As such, online information related to healthcare is largely unregulated and can vary in both accuracy and quality (118). As of June 2019, 58.8% of the worldwide population have access to the internet (119). It is suggested that 91% of adults in the UK use the internet (120) and that 73% of UK adults use the internet as a source of healthcare information (121). Increasing internet access, when combined with patient expectation as being a potential cause of increased use of diagnostic imaging within the NHS, needs to be considered within the wider context of a strategic prioritisation of individualised care informed by shared decision making. It is possible that the content within public-facing websites is informing patient expectations regarding the requirement for diagnostic imaging.

As people use the internet for health information more and more, it appears that the quality of the information remains varied. A study from 2005 demonstrated that the majority of online information related to osteoarthritis (OA) was of poor quality (122). A more recent cross-sectional study of online information for OA accessed via public-facing search engines, demonstrated that the majority of online information was now of a high standard however, wide variety within this information still remains (123). The standard of information was determined using a quality proforma devised by the research team. Whilst this proforma was developed from validated tools for the quality assessment of online information, the proforma was not validated. The quality of online information for LBP, however, remains unclear. A cross-sectional

study in 2003 demonstrated that most of the online information for LBP was of poor quality (124). The reasons behind the quality being poor were varied but included a lack of peer review, out-of-date information, and conflicts of interest of those who created the webpages. A more recent study published in 2012 corroborated the concerns around poor quality, with the information available not being uniformly consistent with recommendations from CPGs (125).

Within this environment of mixed information, it can be difficult for patients to identify a trustworthy source. Further compounding this is that many patients may not have the capability to appraise website content nor recognise the strengths, weaknesses, or credibility of the information (126). To date, studies have focused on the quality and readability of website content in relation to specific disease processes for example, OA or specific body site such as the lower back. There is an absence of research identifying and mapping content of written healthcare information related to specific components of clinical delivery, such as diagnostic imaging, across disease processes and body sites. Such research would allow for similarities and differences in relation to information provided to be identified as well as understanding how the website content aligns with best available evidence. In doing so, it can be established whether any differences seen are justified or reflect unwarranted variation, as well as highlighting priority areas for future development or informing potential educational strategies aimed at reducing unnecessary diagnostic imaging use.

There is a clear need to understand what online information exists that is available to patients about diagnostic imaging for MSK pain conditions. This scoping review is the first step towards that understanding.

The aim of this scoping review was to identify and map the content of public-facing websites with respect to the use of diagnostic imaging for adults with LBP, knee, and shoulder pain.

Review Objectives

- To identify existing public-facing websites that may be used as sources of written healthcare information for people with LBP, knee, and shoulder pain.

- To describe and summarise website written content in relation to the use of diagnostic imaging for LBP, knee, and shoulder pain.

- To identify similarities and differences across websites and written information provided relating to the use of diagnostic imaging for those with LBP, knee, and shoulder pain in order to understand the influence of website quality on recommendation consistency.

3.1 Methods

3.1.1 Design

A scoping review was chosen as the appropriate method given this enables horizon scanning through identification of different types of available online information, as

well as identifying gaps that inform future research. (50,51). This scoping review was designed with reference to guidance from Peters et al. 2015 (53) and Tricco et al. 2018 (55) which is described in detail in **section 3.1.1**. The protocol **(Appendix 10)** for this scoping review was published a priori (Open Science Framework: https://osf.io/x3dq5) on the 21st February 2020. The protocol for the scoping presented in the previous chapter was not published a priori as the existence of the Open Science Framework was unknown to me at that time. Within a scoping review, the search strategy is intended to be comprehensive with each stage of the search and the process of search strategy development clearly outlined. To inform the search strategy (including selection criteria of websites to be included within the review) a Patient and Public Involvement and Engagement (PPIE) meeting was conducted. This meeting was attended by five members of the public who have all sought healthcare for various MSK conditions previously. The five members were made up of two white males, aged 55 and 69; and three white females, aged 35, 63 and 68. The output of this meeting was a co-designed search strategy between the PPIE meeting attendees and the research team.

The PPIE group was in general agreement that they would not necessarily seek clinical guidance at the onset of their MSK pain and would give the problem time to resolve. If the problem did not resolve, they were more likely to seek information to better understand their problem and guide their expectations. The attendees agreed that the online search engine Google would be the means of the information search. An initial search strategy was drafted by the lead author (AC) within the PPIE meeting and then refined by the PPIE group.

The initial draft search strategy consisted of the following terms:

- Back pain
- Knee pain
- Shoulder pain

When utilising Google, the PPIE group was unanimous that they would be very specific in their search by describing their symptoms and that the above initial draft search strategy was too broad. The suggested approach was to utilise both a broad search and a more specific search. As such, the following search strategy was agreed upon by the PPIE group, comprising six individual searches in Google:

  - Low back pain
  - Knee pain
  - Shoulder pain
  - Why does my back hurt?
  - Why does my knee hurt?
  - Why does my shoulder hurt?

Previous published reviews of public-facing websites have limited their searches to the first 50 websites (122). With the PPIE meeting this approach was discussed. The majority of participants stated that they would not visit more than two or three websites from their search and would never go beyond the first page (of listings of 'hits') as, from experience, these websites often appear to be less relevant. The PPIE group agreed that for the purpose of this research study, limiting the search to

the first 50 websites in line with previous research was acceptable and should provide a comprehensive search of websites.

The following selection criteria was used to determine which websites are included within this review (Tables 5 and 6).

Table 5: Criteria for inclusion within the scoping review of public-facing websites that may be used as sources of written healthcare information in those with LBP, knee, and shoulder pain.

Criterion	Justification
Public-facing websites providing written healthcare information related to either LBP, knee or shoulder pain (including advertising websites) that are either based within the United Kingdom (UK) or are NHS affiliated.	The focus of this review is on the lower back, knee, and shoulder. This focus stems from epidemiological evidence of the prevalence of these MSK pain presentations; they represent the most common body sites for MSK pain in the upper limb, lower limb, and spine, respectively (6). This will provide opportunity to compare and contrast between the most researched area of LBP and the lesser researched upper limb and lower limb. The PPIE group explained that they would visit a website for healthcare information if it appeared trustworthy. There was unanimous agreement that a website appeared a trustworthy source if it was either based in the UK or if the website was NHS affiliated. If the website did not meet this criterion, then the attendees described that they would not visit this website. A website was considered to be NHS affiliated if it possesses a nhs.uk domain or contains ‘nhs’ within the Uniform Resource Locator (URL). A website is considered to be based within the UK if it has a .uk domain. Those websites where it is unclear, for example those with a .org, .net or .com domain were visited to determine host country.

	Public-facing websites that did not contain information relevant to diagnostic imaging were still included in the charting of the results, consistent with the function of a scoping review to map the available information related to the topic of interest (51). Those websites that are included but did not contain information relevant to diagnostic imaging were not quality appraised as quality appraisal is not a compulsory stage of a scoping review and is regarded as optional. Appraisal of these websites would add little to the review given the objectives and the absence of information related to diagnostic imaging.

Table 6: Criteria for exclusion within the scoping review of public-facing websites that may be used as sources of written healthcare information in those with LBP, knee and shoulder pain.

Criterion	Justification
Video-sharing platforms such as YouTube or Google Video or audio links.	The focus of this scoping review was to evaluate the written information provided on public-facing websites, rather than that provided in other multimedia formats such as audio or video. Further, given the breadth of the search strategy, excluding non-written information facilitates a manageable scope given the amount of information that would be retrieved.
Non-accessible websites	Websites that are not freely accessible to the public e.g. behind a paywall or require subscription, are unlikely to be explored by patients
Journal articles or websites.	The focus of this review related to public-facing websites, whilst some patients may engage with scientific literature, this is unlikely to be representative of the wider patient population.

3.1.2 Search Strategy

A comprehensive search strategy was used in accordance with recent guidance for conducting a scoping review (53,55). The lead author (AC) entered the following search terms into the Google search engine on the 9th June 2020, as six individual searches:

- Low back pain
- Knee pain
- Shoulder pain
- Why does my back hurt?
- Why does my knee hurt?
- Why does my shoulder hurt?

To ensure that the first 50 hits were recorded and remained constant throughout the review process, the lead author (AC) recorded the website domain of each of the websites returned by the search in a Microsoft Excel (Microsoft Corp., Redmond, WA, USA) document. This ensured that the selection criteria could be independently applied by two reviewers (AC and TJ) without risk of the websites that were returned by the search being different. TJ is an experienced, Senior Physiotherapist who supported the conduct of this scoping review by acting as the second reviewer.

The selection criteria were independently applied by two members of the review team (AC and TJ) to each of the websites returned by the searches. Where there was any discrepancy, this was resolved through discussion and a third member of the review team was available to arbitrate (primary academic supervisor) in the event of disagreement.

When viewing the websites, it was anticipated that multiple pages may need to be viewed in order to fully understand the context and obtain the information required to achieve the review objectives. As such, it was necessary to apply boundaries to the search to ensure consistency, reproducibility, and rigour. Within each website, a

hyperlink (a link to a webpage in another location) or Portable Document Folder (PDF) that led to information hosted within the same website was explored and included within the data extraction and analysis. A hyperlink which leads to information hosted within an external website was not explored or included within the data extraction and analysis. If multiple pages were viewed, or hyperlinks/PDFs explored within the same website this represented one 'hit' rather than multiple 'hits' in the context of the first 50 hits being reviewed.

3.1.3 Quality Appraisal

A scoping review allows for the mapping and collation of existing evidence whilst identifying gaps and informing future research. Formal appraisal of methodological quality is generally not performed in scoping reviews and is regarded as optional (54). Quality appraisal was used within this review to explore the basis for clear and substantial differences in recommendations between websites with the hypothesis that those websites making substantially different recommendations would be of poorer quality. Within the protocol **(Appendix 10)** it was outlined that quality appraisal would be reserved only for those incidences where there are clear and significant differences in recommendations. However, it became apparent that to inform this judgement, all websites would need to be appraised. This represents a deviation from the protocol with the rationale for this outlined within **4.2.4.**

The DISCERN Tool **(Appendix 12)** has been designed to help consumers of written health information to appraise the quality of the information provided without the need for specialist knowledge. Lay members were involved in the development of

the tool (126). The tool consists of 15 questions that each relates to a separate quality criterion underpinning the readability of the information and the extent to which detail is provided. In addition to the 15 questions, there is an overall quality rating scored on a five-point Likert scale ranging from 1 (the information source is poor with extensive shortcomings) to 5 (the information has minimal shortcomings and is ‘good’ quality) (127):

> If a website scores either a 4 or 5 on the majority of the questions, this would indicate that the website is of ‘good’ quality and is a both a useful and appropriate source of information.
>
> If a website scores a mixture of high (4 or 5) or low (1 or 2), or most questions score in the mid-range (a score of 3), this will indicate that the website is of ‘fair’ quality and should be considered a useful source of information with some limitations.
>
> If a website score either a 1 or 2 on most of the questions, this would indicate that the website is of ‘poor’ quality. In turn, it should be considered to have serious shortcomings, to not be a useful or appropriate sources of information and in turn should not be used.

This tool has demonstrated acceptable reliability for use (126) and has been used to appraise the quality of written health information in similar reviews of website information (117,122).

The websites were appraised by AC using the DISCERN Tool and verified by TJ. Where there was any discrepancy, this was resolved through discussion and a third member of the review team was available to arbitrate (primary academic supervisor) in the event of disagreement.

3.1.4 Charting the results (Data Extraction)

The relevant characteristics of the included website(s) and the key data relevant to the review objectives were recorded in a charting table. A separate charting table was populated for LBP, knee, and shoulders websites **(Tables 7-9)**

Data extraction was independently trialled by AC and TJ on the first five included websites to assess the suitability and capacity to chart all relevant information required to answer the review objectives. No changes to the data charting table were required. AC and TJ were the reviewers responsible for charting the results. A third member of the review team (primary academic supervisor) arbitrated in the event of disagreement.

3.1.5 Narrative Synthesis

To summarise recommendations, and to identify similarities and differences across public-facing websites a narrative synthesis was undertaken using thematic analysis. This analysis followed the six principles outlined by Braun and Clarke (128) whereby the aim of the thematic analysis is to identify, analyse and report patterns within the data.

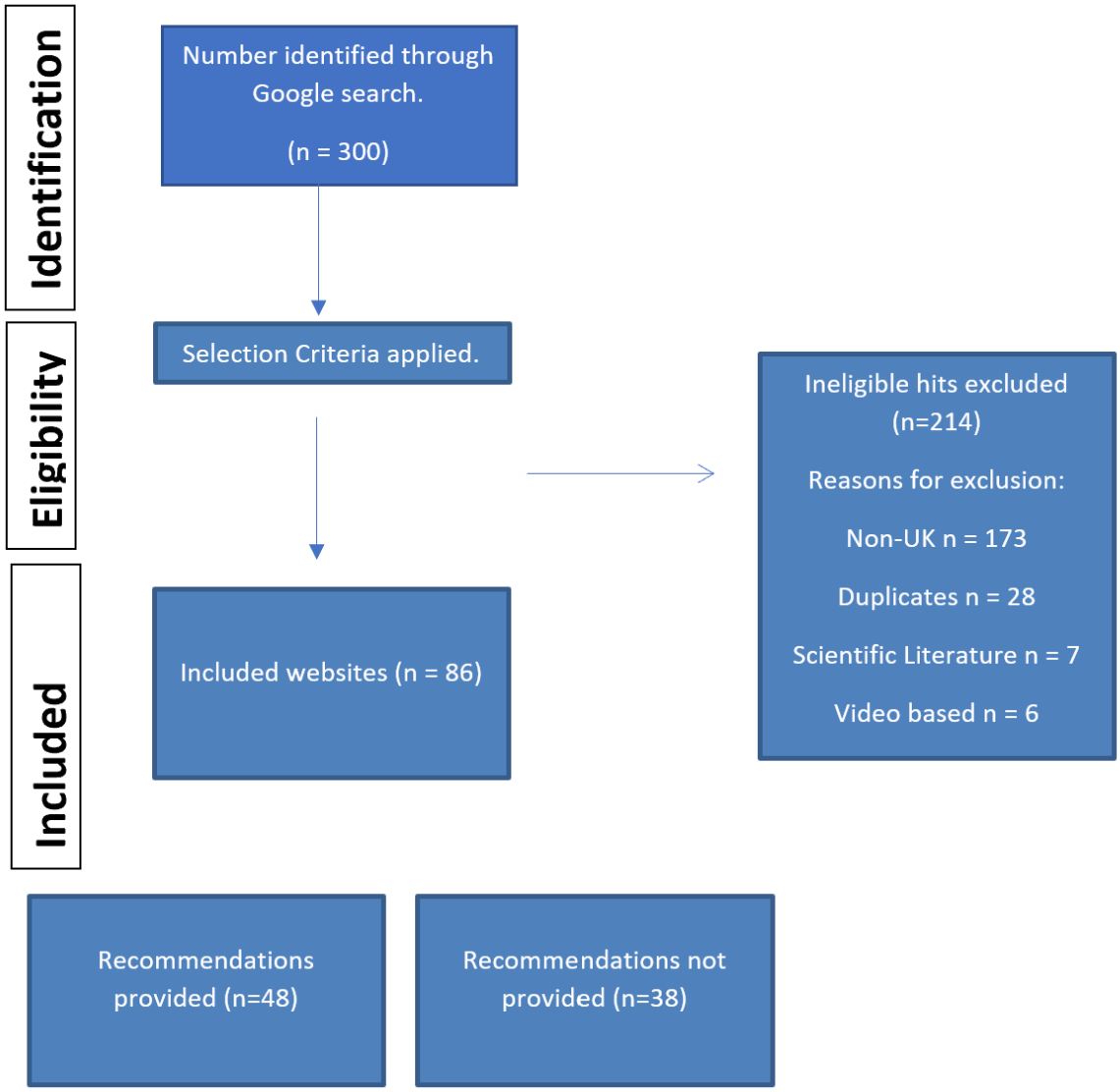
The initial step involved familiarisation of the data extracted through a process of reading and re-reading (Step 1). During this process, codes were applied to aggregate the text (Step 2) before being organised together to form preliminary themes (Step 3). A theme is a broad unit of information that is made up of several codes grouped together to form a common idea (129). This analysis was conducted independently by AC and verified by a second member of the review team (TJ). Where there was any discrepancy, this was resolved through discussion and a third member of the review team was available to arbitrate (primary academic supervisor) in the event of disagreement. These preliminary themes were then critically reviewed by all members of the research team, refined, and iteratively developed (Step 4) in order to provide more meaning to the data prior to the final themes being defined (Step 5). The final step involves outlining the results of the analysis.

3.2 Results

3.2.1 Website Selection

Figure 3 depicts the study selection process. From 300 identified websites, 214 were excluded leaving 86 public-facing websites included in the review.

Figure 3: Flowchart of the website selection process



3.2.2 Regional MSK Condition and Recommendations

Within the websites included in this review, 38 (n = 14 for LBP; n = 14 for knee pain; n = 10 for shoulder pain) did not provide any recommendations or information on the use of diagnostic imaging.

Of those public-facing websites that did provide recommendations or information on the use of diagnostic imaging (n = 48), n = 17 were related to LBP, n = 15 for knee pain and n = 16 for shoulder pain.

3.2.3 Public-facing websites and their recommendations or information on the use of diagnostic imaging

A charting table for LBP, knee, and shoulder pain was created to map the selected websites **(Tables 7-9).**

Table 7: This table provides an overview of the included public-facing websites for LBP and their recommendations or information provided on the use of diagnostic imaging.

Website Domain	Year of content creation	Year of most recent update	Discern Score	Target Audience i.e. public, clinicians	Key Findings that relate to the review questions (Inc. recommendations for/against diagnostic imaging and under what circumstances)
https://www.nhs.uk/conditions/back-pain/ (130)	Not recorded	14/01/2020	3	Public	If you need an X-ray, it might be possible to have one at the unit, or you may be referred to hospital (Sprain or strain). If your symptoms do not get better, your GP might recommend further tests, like an MRI scan (Slipped disc). Your rheumatologist will carry out imaging tests to examine the appearance of your spine and pelvis. These may include an X-ray, a MRI scan or an ultrasound scan (Ankylosing Spondylitis). (Ankylosing Spondylitis) Spondylolisthesis can easily be confirmed by taking an X-ray of your spine from the side while you're standing. This will show whether a bone in your spine has slipped out of position or if you have a fracture. If you have pain, numbness, tingling or weakness in your legs, you may need additional tests, such as a CT scan or an MRI scan. These more detailed scans will be able to help work out whether you have a compressed nerve in your back (Spondylolisthesis). In hospital you are likely to have X-rays taken of your arms, legs, skull, spine and pelvis to look for any damage.

					It's likely you will also need other scans, such as CT scans and MRI scans (Multiple Myeloma). An X-ray can usually confirm the diagnosis and determine the cause of the kyphosis. Further scans are usually only required if complex treatment, such as surgery, is being planned, or if you have additional symptoms that suggest your nervous system has been affected, such as numbness in your arms or legs. If you need additional scans you'll probably have a: • computerised tomography (CT) scan – where a series of X-rays are taken to build-up a detailed 3-dimensional image of your spine • magnetic resonance imaging (MRI) scan – where strong, fluctuating magnetic fields are used to produce a detailed image of the inside of your spine (Kyphosis).
https://www.bupa.co.uk/health-information/back-care/back-pain (131)	Not recorded	November 2019	4	Public	This is because there are so many different parts to your back and tissues that surround it. Even tests such as X-rays and MRI scans don't help for most people. Usually further tests won't help. But if you have other symptoms, your GP may recommend tests including: • an X-ray • an MRI scan (a test that uses magnets and radio waves to produce images of the inside of your body) If you're at risk of having osteoporosis, your doctor will carry out an assessment. They'll examine you, and ask you questions about your lifestyle and family medical history. You may be offered a **DEXA (dual energy X-ray absorptiometry) scan.** This measures the density of your bones. The scan is painless and takes 10 to 20 minutes. (Osteoporosis)

					You may have several tests to help diagnose ankylosing spondylitis, including the following. • An X-ray of the bones and joints in your back. • An MRI scan of your back – this may show up changes at an earlier stage in the disease than an X-ray (Ankylosis Spondylitis) Your GP may offer you tests to find out whether your symptoms may be due to cancer or are caused by another condition. These tests may include: • blood tests • X-rays • scans, including ultrasound, computerised tomography (CT) and magnetic resonance imaging (MRI) (Cancer). Your chiropractor may advise you to have further tests such as a blood test, X-ray or MRI scan if they think it will help to make a diagnosis. They'll talk to you about why they think these tests are necessary and how you can arrange them. (Chiropractic for low back pain).
https://www.nursingtimes.net/clinical-archive/pain-management/back-pain-23-03-2009/ (132)	March 2009	Not recorded	4	Clinicians	Usually, there is no need for tests, such as X-rays or scans, when diagnosing back pain. If you have simple back pain, tests are not always helpful because they often do not show anything unusual. You'll only usually be sent for tests if your pain lasts for longer than six weeks, if you have had an injury or blow to your back, or if your GP suspects that there may be an underlying cause for your pain. For suspected disc problems, X-rays or a computerised tomography scan (CT scan) may be required. Your GP may suggest having a magnetic resonance imaging (MRI) scan, that

					uses a strong magnetic field and radio waves to produce detailed images of the inside of your body, in order to provide more accurate information about the soft tissues in your back. In some cases, blood tests or a myelogram (a special kind of X-ray using an injected dye) may be needed. Chiropractic treatment tends to involve a more 'direct' approach, with an emphasis on adjustments of the spinal joints. Chiropractors also rely on X-rays, blood and urine tests and MRI scans for diagnosis.
https://www.versusarthritis.org/about-arthritis/conditions/back-pain/ (133)	Not recorded	Not recorded	3	Public	National guidelines suggest that doctors should use a common-sense 'wait and see' approach when diagnosing back pain before deciding if you need further treatment, especially as most cases of back pain improve by themselves. You may be sent for tests if: - you've had an injury to your back, for example a bad fall - your doctor suspects that there may be an underlying cause for your pain - the pain has lasted for an unusually long time. In this case a magnetic resonance imaging (MRI) scan or computerised tomography (CT) scan may be needed. X-rays are much less commonly used because back pain is often caused by problems with soft tissues, such as ligaments and muscles, which can't be seen on x-rays. Changes to the spine as a result of spondylosis can show up on x-rays. These common changes that happen to us all can appear on x-rays without people having any pain or problems. Because of this, x-rays aren't particularly helpful.

					Remember that sometimes even after a thorough investigation it might not be possible to say for certain what is causing back pain. If your doctor thinks you may have osteoporosis, they may suggest you have a DEXA (dual energy x-ray absorptiometry) scan to measure the density of your bones. The scan is readily available and involves lying on a couch, fully clothed, for about 15 minutes while your bones are x-rayed. The dose of x-rays is very small – about the same as spending a day out in the sun. The possible results are: Normal – Your risk of a low-impact fracture is likely to be low. Osteopenia – Your bone is becoming weaker but your risk of a low-impact fracture is relatively small. You may or may not need treatment depending on what other risk factors you have. You should discuss with your doctor how you can reduce your risk factors. Osteoporosis – You have a greater risk of low-impact fractures and you may need treatment. You should discuss this with your doctor. There's no good evidence that screening everybody for osteoporosis would be helpful. However, you should talk to your doctor about having a scan if any of the following apply to you: - you've already had a low-impact fracture - you need steroid treatments for 3 months or more - you had an early menopause (before the age of 45) - either of your parents has had a hip fracture - you have another condition which can affect the bones – for example, coeliac disease, inflammatory bowel disease (Crohn's disease or ulcerative colitis), rheumatoid arthritis, diabetes and hyperthyroidism (overactive thyroid)

					- you have a body mass index (BMI) of less than 19. (Osteoporosis) There is no one test that can show for certain that you have ankylosing spondylitis. A diagnosis will be made based on several things, including: - the history of your condition and the symptoms you've experienced, including whether pain and discomfort is waking you up during the second half of the night - a physical examination - blood tests, which may show inflammation - x-rays or a magnetic resonance imaging (MRI) scan - your age. It can be diagnosed at any age, but most often begins before the age of 40, and often much younger.
https://www.your-pharmacy.co.uk/shop-by-brand/nurofen/back-pain/cat-2005?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B8u6y-9ZbfLAFhdshlwFeB4lxHtiF70eGFbjmFbESsZhc8zv41gZUcaAqBmEALw_wcB&gclsrc=aw.ds (134)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
http://elitehealthchiropractic.co.uk/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B-JscJJGW6FIpci8rrXXXEb0L5R-jqUGOXjdrJZQkaR1yWnNUhSgr8aAl8rEALw_wcB (135)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.

https://www.anadin.co.uk/whats-your-pain/back-muscle-pain?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B-j83XNdLF-ebETC2PYC_K4FGCnkNDG3uB6kRGtLRublWr3pe9VcR8aAqpnEALw_wcBb(136)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://patient.info/bones-joints-muscles/back-and-spine-pain/lower-back-pain (137)	Not recorded	December 2016	4	Public	Do I need any tests? Usually not. Your doctor will usually be able to diagnose nonspecific low back pain from the description of the pain and by examining you. Therefore, in most cases, no tests are needed. There is no test that can prove or confirm nonspecific low back pain. In fact, some doctors argue that tests can actually do more harm than good when the diagnosis is nonspecific low back pain. For example, the technical jargon used to report on some scans can sometimes sound alarming, when in fact the scan is just showing what would be normal for a given age and not a cause for pain. Current UK guidelines are clear that routine tests such as X-rays and scans should not be done if the diagnosis is made of nonspecific low back pain. Tests such as X-rays, scans or blood tests may be advised in certain situations. This is mainly if there are symptoms, or signs during a doctor's examination, to suggest that there may be a serious underlying cause for the back pain (Low Back Pain). Your doctor will normally be able to diagnose a 'slipped' (prolapsed) disc from the symptoms and by examining you. (It is the most common cause of sudden back pain with nerve root symptoms.) In most cases, no tests are needed, as the symptoms often settle within a few weeks.

					Tests such as X-rays or scans may be advised if symptoms persist. In particular, a magnetic resonance imaging (MRI) scan can show the site and size of a prolapsed disc. This information is needed if treatment with surgery is being considered. It should be noted that, as explained above, it is known that people can have a disc prolapse without any symptoms. It is therefore very important to make sure that any prolapse seen on a scan matches up with your symptoms. Low back pain is very common and so can happen to someone who has a disc prolapse on their MRI scan, but the disc prolapse is not the cause of the pain (Slipped Disc/Prolapsed Disc). If your doctor thinks that you may have spinal stenosis then an MRI scan will be arranged to confirm the diagnosis (Spinal Stenosis) The diagnosis of CES is mainly based on the symptoms and also by a doctor's examination. Anyone with possible CES should be seen urgently in hospital. Investigations usually include an MRI scan to confirm the diagnosis. Other investigations may include a CT scan and tests of bladder control (Cauda Equina Syndrome). X-ray pictures of the back are sometimes done to assess the angle of the curve. This gives an idea of the severity of the condition and the likelihood of it getting worse. Other investigations - for example, magnetic resonance imaging (MRI) scanning or computerised tomography (CT) scanning of the neck - are needed in some cases (Scoliosis and Kyphosis). This condition is diagnosed from your symptoms and X-ray or magnetic resonance imaging (MRI) pictures. As the disease progresses, typical changes develop on X-ray pictures of the sacroiliac joints and spine. The X-ray pictures show the bones (vertebrae) gradually fusing together. However,

					these changes may take several years to become bad enough to be seen on X-ray pictures. Until recently, the X-ray changes were the only way to confidently confirm AS. More recently, an MRI scan of the sacroiliac joints has been used to confirm the diagnosis at an earlier stage. An MRI scan can give a much more detailed view of a joint than a traditional X-ray picture and can detect inflammation in the sacroiliac joints (Ankylosing Spondylitis).
https://www.nice.org.uk/guidance/cg88 (138)	November 2016	Not recorded	4	Public/Clinicians	The therapist or specialist can check if an X-ray or MRI may be needed.
https://www.theguardian.com/society/2018/jun/14/back-pain-how-to-live-with-one-of-the-worlds-biggest-health-problems (139)	June 2018	Not recorded	4	Public	The authors *(of the Lancet Back Pain series)* were scathing about the widespread use of “inappropriate tests” and “unnecessary, ineffective and harmful treatments. The camera lies … MRI scans show up disc degeneration but unfortunately most people will have some Let us start with magnetic resonance imaging (MRI), the scans that use a combination of magnetic fields and radio waves to produce a picture of our insides. They are a miraculous feat of technology and invaluable for clinicians in certain circumstances – but they can also be harmful. Underwood Martin Underwood, co-author of the Lancet series, a GP and a professor at Warwick Medical School explains: “There is a very poor relationship between changes on MRI scans and the presence or absence of low back pain.” While people with low back pain are more likely to have disc degeneration show up on an MRI, so will a large number of people without back pain. As Underwood puts it: “If you get into the business of treating disc degeneration because it’s shown up on an MRI, the likelihood is that, in most of those people, it is not contributing to their back pain.” Of course, says Underwood, MRI scans are appropriate for people who are experiencing neurological symptoms in their

					legs, for which surgery is being considered. But for nonspecific low back pain, he says: “MRI scans probably do more harm than good.” A scan can change a patient’s behaviour, he explains, “because they’re told there’s some wear-and-tear damage in their back; but most people have wear-and-tear damage in their back and when you get to my age, I’m sure everybody does.” It also changes clinicians’ behaviour: “They’re more likely to offer invasive procedures if they can see something on an MRI scan that they can treat,” he says. So why are MRIs used so often? The Lancet papers tell us that “although imaging has a very limited role, imaging rates are high: 39% of patients with low back pain are referred for imaging by general practitioners in Norway, 54% in the USA, and 56% in Italy.” Ramin says: “It’s not because the primary care physician is itching to have them have that MRI, but because the patient insists upon it; they insist upon it because their neighbours and colleagues have had them.” I remember, with quiet shame, requesting an MRI for my low back pain last year.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/384519/low_back_pain.pdf (140)	September 2008	Not recorded	4	Clinicians	Radiographs and MRI or CT scans are often obtained. Abnormalities are frequently found in such imaging. This is often unrelated to symptoms and should be interpreted in the context of the clinical picture. For example, during the investigation of a patient with back pain in whom lumbar disc prolapse is suspected, an MRI scan might be carried out. In order to confirm the diagnosis this might be followed by a provocative test where fluid is injected into the disc itself, using x-ray control. Only then could the surgeon be confident that the disc is the source of back pain. This is also the case for facet joint degeneration – confirmatory tests are used to evaluate suspected sources of pain rather than simply assuming that a radiological abnormality must be the cause of the pain. The loss of disc height will usually be seen on x-rays of the lumbar spine (Spinal Stenosis).
https://www.royalberkshire.nhs.uk/patient-information-	December 2019	Not recorded	4	Public	The Emergency Department doctor will usually be able to diagnose non-specific low back pain from the description of the pain and by examining you. Therefore, in most cases, no tests

leaflets/Pain%20Management/AandE%20Back%20pain%20non%20specific%20lower%20back%20pain.htm (141)					are needed. There is no test that can prove or confirm non-specific low back pain. Current UK guidelines are clear that routine tests such as x-rays and scans should not be done if there is a diagnosis of non-specific low back pain. Tests such as x-rays or scans may be advised only if there are symptoms, or signs during a medical examination, to suggest that there may be a serious underlying cause for the back pain.
https://www.physio-pedia.com/Low_Back_Pain (142)	Not recorded	March 2020	4	Clinicians	Previous research and international guidelines suggest it is not possible or necessary to identify the specific tissue source of pain for the effective management of mechanical back pain. Therefore, the use of diagnostic imaging, especially in the first month, is not recommended. Diagnostic management should only be used if low back pain does not respond to recommended protocols and the management of the condition needs to be changed or more serious pathology is suspected. Abnormalities in x-ray and magnetic resonance imaging and the occurrence of non-specific low back pain seem not to be strongly associated. Abnormalities found when imaging people without back pain are just as prevalent as those found in patients with back pain. Van Tulder and Roland reported radiological abnormalities varying from 40% to 50% for degeneration and spondylosis in people without low back pain. They reported that radiologists should include this epidemiological data when reporting the findings of a radiological investigation. Many people with low back pain show no abnormalities. In clinical guidelines these findings have led to the recommendation to be restrictive in referral for imaging in patients with non-specific low back pain. Only in cases with red flag conditions might imaging be indicated. Jarvik et al reported that computed tomography and magnetic resonance imaging are equally accurate for diagnosing lumbar disc herniation and stenosis — both conditions that can easily be separated from non-specific low back pain by the appearance of red flags. Magnetic resonance imaging is probably more accurate than other types of imaging for diagnosing infections and malignancies,

					but the prevalence of these specific pathologies is low (Specific causes of low back pain). In case of specific lower back pain, other diagnostic procedures are required to confirm diagnosis. Magnetic Resonance Imaging (MRI) and Computed Tomography (CT-scan) may put these diseases forward (radiculopathy, discopathy …). Nevertheless, patients are frequently misdiagnosed. Normal age-related degenerative changes in the spine can be misinterpreted as an initiator of pain, although we can see the same changes in people with no complaints. For this reason, radiological pictures differ according to age, even in patients with no chronic low back pain (Chronic Low Back Pain). If no serious pathology is suspected there is no indication for x-rays or MRI diagnostic imaging unless guidance is needed to change the management protocol (Non-specific low back pain). If CES is suspected the patient must undergo an MRI urgently to confirm the diagnosis. While MRI, coupled with patient history and examination, remains the diagnostic gold standard, it comes at a high cost with many patients demonstrating no concordant pathology (Cauda Equina Syndrome). X Rays - Anteroposterior and lateral plain films, as well as lateral flexion-extension plain films, are the standard for the initial diagnosis of spondylolisthesis. One is looking for the abnormal alignment of one vertebral body to the next as well as possible motion with flexion and extension, which would indicate instability. In isthmic spondylolisthesis, there may be a pars defect, which is termed the "Scotty dog collar." The "Scotty dog collar" shows a hyperdensity where the collar

					would be on the cartoon dog, which represents the fracture of the pars interarticularis. Computed tomography (CT) of the spine - provides the highest sensitivity and specificity for diagnosing spondylolisthesis. Spondylolisthesis can be better appreciated on sagittal reconstructions as compared to axial CT imaging. MRI of the spine can show associated soft tissue and disc abnormalities, but it is relatively more challenging to appreciate bony detail and a potential pars defect on MRI (Spondylolisthesis). X-rays: These are very accessible at most clinics and outpatient offices. This imaging technique can be used to assess for any structural instability. If x-rays show an acute fracture, it needs to be further investigated using CT scan or MRI. CT Scan: It is preferred study to visualize bony structures in the spine. It can also show calcified herniated discs. It is less accessible in the office settings compared to x-rays. But, it is more accessible than MRI. In the patients that have non-MRI comparable implanted devices, CT myelography can be performed to visualize herniated disc. MRI: It is the preferred and most sensitive study to visualize herniated disc. MRI findings will help surgeons and other providers plan procedural care if it is indicated (Disc herniation). The diagnosis of AS is commonly made through a combination of thorough subjective and physical examinations, laboratory data and imaging studies.

					X-rays are the most useful imaging modality in established the disease, although they may be normal in the early phases. X-ray shows up areas where the bone has been worn away by the condition. The vertebrae of the spine may start to fuse together because the ligaments between them become calcified. MRI scanning may also be useful in identifying early sacroiliitis. MRI of the sacroiliac joints is more sensitive than either plain X-ray or CT scan in demonstrating sacroiliitis. Sacroiliitis initially shows as blurring in the lower part of the joint, then bony erosions or sclerosis occur and widening or eventual fusion of the joint (Ankylosing Spondylitis). Scheuermann's disease is diagnosed with lateral radiographs. Scheuermann's disease can be evaluated by other tools such as CT scans or magnetic resonance imaging (Scheuermann's disease). The definitive diagnosis of vertebral compression fracture usually is accomplished using a number of medical imaging. The most widely available and cost-effective initial imaging study is a lateral X-ray of the thoracic or lumbar spine modalities. A plain radiograph may be all that is necessary for a majority of compression fractures, especially if one proceeds with conservative, medical management. CT scans allows for the best imaging of bony anatomy and improved assessment of loss of height, fragment retropulsion, and canal compromise. Magnetic resonance imaging (MRI) is the best study for judging fracture age, as it will show bony oedema (T2) for an acute fracture, allows for the evaluation of neural compromise secondary to compression and will also reveal integrity of the

					spinal ligamentous complex, which can be important during surgical evaluation of fracture stability.
http://crosbyphysio.com/what-we-can-treat/spinal/low-back-pain/ (143)	Not recorded	Not recorded	2	Clinicians	In the management of most cases of low back pain, investigations are not required. However, x-ray should be performed if traumatic fracture, stress fracture, spondylolisthesis or significant osteoarthritis is suspected. It is also advisable to x-ray those patients whose low back pain may not be responding to treatment. MRI scans can be further used to image the internal structure of any suspected disc complaints such as bulges, protrusions or herniations.
https://www.zivaa.com/strong-after-section/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B_N04cdXigYefHsC7zgYk0cJwFPyKBJKs8T629v2ZErA9uyccGANu4aAghnEALw_wcB (144)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.gentle-chiropractic.co.uk/ (145)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.happypsoas.co.uk/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B_r0t6zPhykZO36WTiu4n24HvGDX7lxrAQMN4e-ti9kpRH8mmRjJrgaAhk6EALw_wcB (146)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://chiropractic-uk.co.uk/back-pain/ (147)	Not recorded	Not recorded	2	Public	Seeing a qualified health professional, such as a chiropractor, who is experienced in diagnosing conditions of the back and spine, can help treat back pain, and also identify if a referral or specialist investigations are needed.

					Sometimes it may be necessary to refer you for other tests, such as X-rays, MRI scans or blood tests. It is important for your chiropractor to gather as much information about your back pain as possible so that the most precise diagnosis can be made.
https://www.sportsinjuryclinic.net/sport-injuries/back/low-back-pain (148)	January 2019	Not recorded	2	Public	They may also refer you to the hospital for a scan such as an X-ray, MRI scan or CT scan (Slipped disc). An X-ray can confirm the diagnosis (Stenosis). If injury to the vertebrae is suspected always seek medical attention as soon as possible. An X-ray will be taken to confirm the diagnosis and the extent of the injury. The presence of associated injuries should also be investigated due to the level of force required to fracture a transverse process. CT or MRI scans may also be performed (Transverse Process Fracture). If the cause of your sciatica is thought to be spinal – i.e. coming from the lower back in the form of a disc prolapse, degeneration, stenosis etc, then you will probably be referred for imaging, in the form of either an X-ray or MRI scan (Sciatica). Usually, damage at the facet joint can be seen on plain X-rays, which are taken from front to back, side to side and obliquely across the joint. In some cases, a CT scan can be used instead as this will show up more detail of other structures in order to rule them out. If nothing is found, an MRI scan may be taken to reveal any problems with associated structures such as discs and ligaments of the spine (Facet Joint Pain). If you have back pain after a fall, seek medical attention. After an examination, a doctor may request an X-ray or a CT scan to confirm the diagnosis (Traumatic Compression Fracture). An X-ray in a position that triggers the pain can confirm the diagnosis (Spondylolisthesis). Diagnosis may be confirmed by X-ray although a recent injury may not always show up. A bone scan or better still, a ‘single

					photon emission computed tomography (SPECT) scan can give a more accurate image (Spondylolysis).
https://www.ouh.nhs.uk/patient-guide/leaflets/files/5712Plowbackpain.pdf (149)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.qvh.nhs.uk/wp-content/uploads/2015/09/Chronic-Lower-Back-Pain.pdf (150)	November 2012	Not recorded	2	Public	Degenerative changes are most common in the facet joints (connections between the bones in the spine) and discs of the lumbar spine. Discs may have narrowed, and facet joints may have worn and become rough. These changes may show up on x-ray, but do not always give pain (Degeneration/ 'wear and tear').
https://www.theguardian.com/lifeandstyle/2015/nov/30/everything-you-ever-wanted-to-know-about-back-pain-but-were-afraid-to-ask (151)	November 2015	Not recorded	3	Public	Experts agree that imaging (x-rays and scans) are not needed for LBP that has lasted for fewer than four weeks, when there are is no concern about serious underlying disease. As Williams (Australian academic Dr Christopher Williams) says: "There is no correlation between back pain and the structural diagnoses that patients often receive (for example, a disc bulge) as a result of a scan, so these are not usually helpful."
https://www.leukaemiacare.org.uk/support-and-information/latest-from-leukaemia-care/blog/could-muscle-or-back-pain-indicate-leukaemia/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9TdHPxx1TDamtbD64HQ2JzPH6-xuQ26FbXXlxjXmaAKT4TvuCireQaAsv1EALw_wcB (152)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.

https://www.back-pain-mri.com/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B8wow9reAsvACifbODwiQTZ2-srqgJaFqHS9jKbo-9Ea1CriZMoPoYaAvLqEALw_wcB (153)	Not recorded	Not recorded	2	Public	In most cases, however, the true causes of back pain cannot be located precisely. Because conventional examination methods such as computed tomography (CT) or tunnel MRI systems cannot do one thing: examine the affected region under the body's natural weight-bearing conditions. For example, if a patient suffers from back pain while sitting or standing, the CT or tunnel MRI examination in the lying position will often not reveal anything. The Medserena Truly Open Upright MRI is different. The system can provide clarity in the search for the real cause of pain. Causes of pain have finally become visible. Why? Because the Upright MRI, also known as the seated MRI, makes it possible to examine the body under its natural weight-bearing load and thus provides better diagnostic results. That's because patients often complain of pain symptoms when they are sitting, standing, or walking that usually cannot be detected when lying down in a tunnel MRI system.
https://topmri.com/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9WnHQSTDb7QtxW1jT7Kg8oo4tTExH6rplW9GpJPxkgBs704ILBAq4aAjpyEALw_wcB (154)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.brainandspine.org.uk/supporting-you/helpline/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B-ohMBHK-hxtm-d3nfeDZYLMpFElZ7eo5YQFVvdf7CTy5nvhoaz3d0aAlbKEALw_wcB (155)	Not recorded	Not recorded	4	Public	Doctors can use different kinds of investigations to try to find out what is causing your symptoms. Depending on your particular symptoms, you may be referred for a variety of tests and investigations. A brain or spine scan is an investigation. Your doctor or specialist will refer you for a scan and use the results to assist them in making a diagnosis. There are two main types of brain scan and spine scan: CT scans and MRI scans.

					A CT scan is a Computerised Tomography scan. It is a special type of X-ray using a scanner and computer equipment to take pictures of the brain or spine. It differs from a standard X-ray as it produces pictures of cross-sections of the brain or spine. You will be asked to lie on a scanner table. You should mention if you are uncomfortable because it is important that you are able to keep still during the scan. An MRI scan is a Magnetic Resonance Imaging scan. It uses strong magnetic fields and radio waves to take pictures of the brain or spine. You will be asked to lie on a scanner table. You should mention if you are uncomfortable because it is important that you are able to keep still during the scan.
https://blog.sfceurope.com/why-is-my-back-aching-after-a-shift (156)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.manchestereveningnews.co.uk/news/fashion-news/why-does-my-back-hurt-during-sex-986123 (157)	January 2013	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.capitalphysio.com/fitness/lower-back-pain-from-squats-why-this-happens-and-how-to-avoid-it/ (158)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.refinery29.com/en-gb/lower-back-pain (159)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.independent.co.uk/life-style/health-and-	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.

families/features/back-pain-i-was-only-in-my-early-thirties-ndash-but-i-felt-like-an-old-lady-1975563.html (160)					

Table 8: This table provides an overview of the included public-facing websites for knee pain and their recommendations or information provided on the use of diagnostic imaging.

Website Domain	Year of content creation	Year of most recent update	Discern Score	Target Audience i.e. public, clinicians	Key Findings that relate to the review questions (Inc. recommendations for/against diagnostic imaging and under what circumstances)
https://www.amazon.co.uk/s?k=knee+pain&adgrpid=55947714471&gclid=Cj0KCQiA7OnxBRCNARIsAIW53B8FKCAcP8-vF9auxP8r4og_BKXfwnvS8iy0IqEjpWyJE774bvVerwgaAnPQEALw_wcB&hvadid=259047401210&hvdev=c&hvlocphy=1007064&hvnetw=g&hvqmt=e&hvrand=12489158696302928342&hvtargid=kwd-10397122&hydadcr=170_1736084&tag=googhydr-21&ref=pd_sl_80h8usedd9_e (161)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.nhs.uk/conditions/knee-pain/ (162)	Not recorded	December 2017	3	Public	You may be referred to hospital for a scan if your doctor thinks you could have another injury, such as a broken bone (Tendonitis). Your GP may need to refer you for tests such as an X-ray, MRI scan, or arthroscopy to find out if your cartilage is damaged (Cartilage Damage). Further tests – such as X-rays or blood tests – are not usually necessary, but may be used to rule out other possible causes, such as rheumatoid arthritis or a fractured bone (Osteoarthritis).

					If your symptoms do not get better after treatment, you may be referred for further tests, such as scans to look for other causes, such as damage to the muscles (Bursitis). You might be sent for a blood test, ultrasound or X-ray (Gout).
https://www.versusarthritis.org/about-arthritis/conditions/knee-pain/ (163)	Not recorded	Not recorded	3	Public	Your doctor will often be able to diagnose your knee problem from your symptoms along with a physical examination of your knee. Occasionally, they may suggest tests or a scan to help confirm a diagnosis – especially if further, more specialised treatment may be needed (Knee Pain). X-rays aren't usually helpful in diagnosing osteoarthritis, although they may be useful to show whether there are any calcium deposits in the joint. In rare cases, an MRI scan of the knee can be helpful to identify other possible joint or bone problems that could be causing your symptoms (Knee Osteoarthritis). X-rays aren't usually helpful as cartilage doesn't show up on them. Your doctor may suggest a magnetic resonance imaging (MRI) scan, for example if you've had a blow to your knee (Patellofemoral Pain).
https://www.bupa.co.uk/health-information/knee-clinic/explore-knee-pain (164)	Not recorded	Not recorded	5	Public	They may suggest an X-ray or a magnetic resonance imaging (MRI) scan, but this is often not necessary. The examination and your history may be enough to diagnose you (Anterior Knee Pain/Medial Knee Pain/Lateral Knee Pain). If you have signs of a popliteal cyst, your doctor may suggest an ultrasound scan. If they suspect a posterior cruciate ligament injury, they may suggest an X-ray or a magnetic resonance imaging (MRI) scan (Posterior Knee Pain).
https://www.voltarol.co.uk/pain-treatments/knee-pain/ (165)	Not recorded	Not recorded	3	Public	If pain is long lasting or more severe, you should see a doctor or specialist. They may perform a physical examination to test the mobility of your joint as well as inspect for swelling, tenderness, visible bruising and warmth and recommend physical therapy and knee braces to relieve knee pain. He or she may also order imaging tests such as an X-ray, MRI, ultrasound or CT scan.

https://www.runnersworld.com/uk/health/injury/a773762/4-causes-of-knee-pain-and-how-to-fix-them/ (166)	July 2017	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://uk.hisamitsu/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B8SuMfelbVI_lJBJ-jOY8vjnu4d9p0MlUU7B3HfDdf_H49fxD0JaKEaAkbMEALw_wcB (167)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.ultralieve.com/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B_BF2uYTBVG1kZwgJV7Pc7MON8BkKld_2LS1hoyU_WiEL4uFDqeU7saAiL5EALw_wcB (168)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.blackberryclinic.co.uk/landing_page/prolotherapy/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B_M0Ssv0CQg2X4jscRdlBQp7-5Xu1FDXs7heuIId-xAUEJORYf2qP4aAtmVEALw_wcB (169)	Not recorded	Not recorded	2	Public	Further diagnostic imaging may be required to determine if you have osteoarthritis. A thorough history is taken to find out how the knee pain started followed by a physical examination. If further investigation is required you may be referred for ultrasound scan, x ray or MRI scan. An accurate diagnosis will mean that the most appropriate treatment for your condition will be started as soon as possible (Knee Pain). A clinical examination will usually find the point of tenderness, and depending on the level of muscle function, the level of damage to the tissue can be determined. An ultrasound scan can also help identify between different types of soft tissue muscle injuries (Muscle Tear).

					Bursitis is usually diagnosed during a physical examination. There is usually localised pain or swelling, tenderness, and pain with movement of the affected area. MRI and ultrasound scans can be used, but are not always necessary (Bursitis). You will need a thorough physical examination of the joint and will need to describe the mechanism of the injury to your therapist or doctor. In some cases, you will be referred for an MRI scan to see if the ligament has ruptured completely (Ligament Injury). A thorough clinical examination is required to find the cause of the swollen knee. Further diagnostic imaging may be required to highlight any dysfunction (Swollen Knee). You may need to be referred for further investigations such as ultrasound or MRI to determine the extent of the injury (Tendon Injury).
https://www.active650.co.uk/products/full-knee-support?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B_5xdixmpKHtnzv9mdU_WaBHHiicZxI4Nb4s4KfMw6UNO--_2AWptIaAgAwEALw_wcB (170)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.sportsinjuryclinic.net/sport-injuries/knee-pain (171)	January 2019	Not recorded	2	Public	An MRI scan can confirm the diagnosis of an ACL sprain. An X-ray is only useful to detect a bony injury such as an associated avulsion fracture. This is where the ligament tears, pulling a small piece of bone away with it (ACL). They may refer to an MRI scan and/or X-ray to assess the extent of the damage (PCL).

					A professional therapist will undertake a thorough assessment and make an accurate diagnosis to confirm cartilage meniscus injury and they may undertake an MRI scan to determine the extent of the injury. An MRI scan is often used to confirm the diagnosis (Meniscus). A sports injury professional can correctly diagnose the injury and extent of the damage which may require an X-ray or arthroscopy (Articular Cartilage Injury). In order to correctly diagnose a fracture, an X-ray must be performed. If soft tissue (ligaments, cartilage, etc) damage is suspected an MRI scan may also be advised (Tibial plateau fracture). To diagnose osteoarthritis the clinician might assess the nature and severity of pain. The will measure the amount of movement in the joint and take an X-ray of the knee. Narrowing of the joint space is a good indicator of osteoarthritis. Bony spurs can also be seen on an X-ray. In some cases, an MRI scan may be necessary. This allows the clinician to see whether soft tissue changes have taken place within the joint (Osteoarthritis). In more serious cases an MRI scan and/or X-Ray may be necessary (LCL Injury). Osgood Schlatter's disease: In extremely severe cases they may do an X-ray to see exactly how much damage has occurred.
https://www.csp.org.uk/public-patient/rehabilitation-exercises/knee-pain (172)	October 2012	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
http://www.southend.nhs.uk/media/188240/kneepaininyoungadults.pdf	March 2014	Not recorded	3	Public	Patellofemoral pain syndrome is usually easily recognised from your description of your symptoms and confirmed by an examination of your knee. X-rays aren't usually helpful as cartilage doesn't show up on the. Your doctor may suggest a MRI scan, for example if you've received a blow to your knee.

http://physio.hey.nhs.uk/common-injuries/lower-limb-injuries/knee-pain (173)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.nidirect.gov.uk/conditions/knee-pain (174)	Not recorded	Not recorded	3	Public	You may be referred to hospital for a scan if your doctor thinks you could have another injury, such as a broken bone (Tendonitis). Your GP may need to refer you for tests such as an X-ray, MRI scan, or arthroscopy to find out if your cartilage is damaged (Cartilage Damage). Further tests – such as X-rays or blood tests – are not usually necessary, but may be used to rule out other possible causes, such as rheumatoid arthritis or a fractured bone (Osteoarthritis). If your symptoms do not get better after treatment, you may be referred for further tests, such as scans to look for other causes, such as damage to the muscles (Bursitis). You might be sent for a blood test, ultrasound or X-ray (Gout). You may need an ultrasound scan or a magnetic resonance imaging (MRI) scan (Baker's Cyst). If you need an X-ray it might be possible to have one at the unit or you may be referred to hospital. Go to the emergency department or call 999 if: ● you heard a crack when you had your injury ● the injured body part has changed shape ● the injury is numb, discoloured or cold to touch You may have broken a bone and will need an X-ray (Sprains and Strains).
https://patient.info/doctor/anterior-knee-pain (175)	Not recorded	June 2015	3	Public	These tend not to be that useful, as diagnosis can often be made clinically.

					X-rays (skyline views should be included with anteroposterior and lateral knee X-rays) may be indicated if there has been a history of trauma. MRI scanning may give much more detail of soft tissues but changes seen may not correlate with the degree of symptoms. (Anterior Knee Pain). **Plain X-rays**: when disease is advanced it can be seen on plain X-rays. **MRI**: may be useful to distinguish other causes of joint pain. X-ray may reveal fracture of any of the bones, erosive disease, calcium pyrophosphate crystals of pseudogout or joint space narrowing. Damage to cartilage or ligaments can be demonstrated by MRI: The Direct Access Magnetic resonance imaging: Assessment for Suspect Knees (DAMASK) trial looked at the influence of early access to MRI of the knee, compared with referral to an orthopaedic specialist, on GPs' diagnoses and treatment plans for people with knee problems. The trial found that access to MRI did not significantly alter their diagnoses or treatment plans but it did significantly increase their confidence in these decisions. There is a significant false positive rate from MRI of the knee. Abnormal findings have been reported in healthy individuals with no knee symptoms: 16% have evidence of meniscal tears, increasing to 36% for people aged over 45 (Knee Assessment). This is not usually required for uncomplicated cases. However, plain X-ray may be required if fracture or dislocation is a clinical possibility. MRI or CT may be required in cases where there is a failure to respond to treatment for septic prepatellar bursitis. Ultrasound may also be useful for diagnosis (Pre-patella bursitis).

https://www.circlehealth.co.uk/integratedcare/knee-pain/ (176)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.nwbh.nhs.uk/knee (177)	Not recorded	Not recorded	3	Public	Diagnosis is usually made from the patient's history and a simple examination without the need for further investigations. Sometimes an x-ray may be arranged if a clinician is uncertain about the diagnosis or wishes to see the extent of the (Osteoarthritis). Diagnosis is usually made from the patient's history and a simple examination without the need for further investigations (Patellofemoral Pain).
https://www.avogel.co.uk/health/muscles-joints/joint-pain/knee-pain/ (178)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.iosteopathy.org/what-we-treat/knee-pain/ (179)	Not recorded	Not recorded	2	Public	X-rays, scans and other tests are sometimes required to make a diagnosis and your osteopath may refer to your GP or a specialist for any additional investigations or treatment (Knee Pain)
https://www.capitalphysio.com/health-news/inside-knee-pain/ (180)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.justanswer.co.uk/sip/orthopedics?r=ppc|ga|5|1683661621|64841937079|&JPKW=%2Bknee%20%2Bpain&JPDC=S&JPST=&JPAD=326911692843&JPMT=b&JPNW=g&JPAF=txt&JPRC=1&JPCD=20190122&JPOP=&JCLT=&cmpid=1683661621&agid=64841937079&fiid=&tgtid=kwd-	Not recorded	March 2020	N/A	Public	No recommendations or information on the use of diagnostic imaging.

18904474954&ntw=g&dvc=c&gclid=Cj0KCQiA7OnxBRCNARIsAIW53B_B7EGcJjrBvQCMvk_9z3lT1MF6czag-MFK0BqtehHb6ivoYicbsUsaAiihEALw_wcB (181)					
http://rahulpatel.net/ (182)	Not recorded	Not recorded	2	Public	It is likely that X-rays and MRI will be requested for most knee injuries.
https://acuraflex.co.uk/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B-Qe2YAeQ1pSFd5P0YwhAvErb8c1XCkZYXAU2rTU3DRYs7XhaRFrbAaAuyPEALw_wcB (183)	Not recorded	Not recorded	1	Public	Magnetic resonance imaging (MRI) of the knee to determine the cause (knee pain).
https://www.nurofen.co.uk/blogs/symptoms-advice/muscular-pain?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9HSWU1P2HqW3dyAv9zhllAEs1uG4lAblXCOkyZn3VBF9PdnY_GukMaAkMCEALw_wcB&gclsrc=aw.ds (184)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.osmopatch.co.uk/conditions/knee-pain/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B8wE8cHKNIeUj-CDmYdN30AysXAapE5bZeaaWvvsr2jFQHAs	Not recorded	November 2019	2	Public	To properly diagnose knee bursitis your doctor will likely get you to have both an x-ray and ultra sound of the knee. If there is an infection suspected then a blood test and maybe an aspiration of the synovial fluid may be required for testing and culturing. In some cases an MRI may also be required to rule out any co-exist conditions that may have contributed to the condition (Bursitis).

qJIihIaAj1KEALw_wcB (185)					In some cases an x-ray and or MRI may also be required to rule out any co-exist conditions that may have contributed to the condition (Baker's Cyst). To determine the cause, your doctor may require an x-ray view to see if there is any broken or dislocated bone in your knee, or find out if the real culprit is irritation due to wear & tear. A magnetic resonance imaging (MRI) test may also be needed to detect any abnormalities of the knee joint such ligament, tendons or cartilage tear (Swollen Knee). Usually an ultra-sound or MRI will be used to properly diagnose patellar tendonitis and rule out that the pain is actually coming from the knee cap (Patella) itself (Knee Tendonitis).
https://www.bmihealthcare.co.uk/health-matters/health-and-wellbeing/whats-wrong-with-my-knee (186)	Not recorded	Not recorded	3	Public	Often the history and examination is strongly suggestive. There is often a twisting and indirect knee injury with a delayed onset of swelling. An instantaneous swelling is often suggestive of an anterior cruciate ligament rupture. On examination an inability to crouch is often present. The gold standard is to obtain an MRI scan which provides an unrivalled view of any structural derangement within the knee (Meniscus).
https://www.betterbraces.co.uk/injury-info-center/knee-injury-guide/inside-knee (187)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://actesso.co.uk/knee-supports-for-injury/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9OQaUihEeVOmhQGwZtMfA1NKnxRauFIul0zg455jzkP7mWLVNifSAaAnuvEALw_wcB (188)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.

Table 9: This table provides an overview of the included public-facing websites for shoulder pain and their recommendations or information provided on the use of diagnostic imaging.

Website Domain	Year of content creation	Year of most recent update	Discern Score	Target Audience i.e. public, clinicians	Key Findings that relate to the review questions (Inc. recommendations for/against diagnostic imaging and under what circumstances)
https://www.amazon.co.uk/s?k=shoulder+pain&adgrpid=52358118199&gclid=Cj0KCQiA7OnxBRCNARIsAIW53B-0UZn4rtwFjHHxgAnk5z5SdRuGeatbWwdVGXReHr6dJ-tUvuI1vBYaAgyjEALw_wcB&hvadid=259085132347&hvdev=c&hvlocphy=1007064&hvnetw=g&hvpos=1t2&hvqmt=e&hvrand=10602600090041679011&hvtargid=kwd-11565081&hydadcr=28148_1724781&tag=googhydr-21&ref=pd_sl_2ww9uipky9_e (189)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
http://www.shoulder2wrist.co.uk/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9j7PArYvk7j3jlG7IUVE3WLhHQDsgXEB1tZWZnVPktf67A1bwtohgaAiz8EALw_wcB (190)	Not recorded	Not recorded	3	Public	Shoulder impingement is a clinical diagnosis. X-rays or other scans are not routinely required but may be requested to rule out other conditions or prior to considering a steroid injection if there is concern regarding the possibility of a rotator cuff tendon tear.
https://www.versusarthritis.org/about-	Not recorded	Not recorded	3	Public	X-rays are good for looking for problems with the bones in your shoulder and minor changes in the joints. However, small

arthritis/conditions/shoulder-pain/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B-0kIEWEDGW5YZbTunEoMuESl5Qua_X5VieespppnF2FDV44Ulz6AaAvFIEALw_wcB (191)					changes are quite common and may not be the cause of your trouble (Shoulder Pain). X-rays can only show bones and other hard substances, but they won't show injuries to soft tissue like muscles (Shoulder Pain). An ultrasound scan can show swelling, as well as damage and problems with the tendons, muscles or other soft tissues in the shoulder. It uses high-frequency sound waves to examine and build pictures of the inside of the body (Shoulder Pain). You may be referred for magnetic resonance imaging (MRI) scans if your doctor suspects a more complex problem with the soft tissue in your shoulder. An MRI uses radio waves to build a picture to show what's happening to the bones and soft tissue, such as the muscles and tendons, inside your shoulder (Shoulder Pain). Sometimes dye is injected into the shoulder before the MRI to get a clearer picture – especially in cases of shoulder dislocation (Shoulder Pain).
https://www.nhs.uk/conditions/shoulder-pain/ (192)	Not recorded	November 2018	3	Public	A GP will examine you to work out what's causing your shoulder pain. They might send you for tests (such as an X-ray) to check the cause. Further tests – such as X-rays or blood tests – are not usually necessary, but may be used to rule out other possible causes (Osteoarthritis). You'll be assessed and examined when you get to A&E. You'll usually have an X-ray to check whether you've broken any bones and confirm the dislocation (Shoulder Dislocation).

https://www.csp.org.uk/public-patient/rehabilitation-exercises/shoulder-pain (193)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.voltarol.co.uk/pain-treatments/shoulder-pain/ (194)	Not recorded	Not recorded	3	Public	Additionally, they may order imaging tests (e.g. an X-ray). If your pain is severe or lasts for a long time you should consult your doctor. He or she may conduct an examination and possibly order a blood test or imaging tests, such as an X-ray, MRI or CT scan to find out the cause of the inflammation.
https://cks.nice.org.uk/shoulder-pain (100)	Not recorded	April 2017	5	Clinicians	Investigations should be guided by the suspected cause. (Blood tests and radiography are not usually indicated as part of a primary care assessment of shoulder pain). • Consider anteroposterior and lateral shoulders X-rays if: o There is a history of trauma. o The person is not improving with conservative treatment or symptoms are lasting more than four weeks. o Movement is significantly restricted. o There is severe pain. o Any red flags are present. o Arthritis is suspected. • Ultrasound or MRI should not usually be requested by primary care.
https://www.ibuleve.com/products?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9TYcEqt0CBD7CytI0kANm4ME5QbNljBOTdV40tch6yX_93m3ICclAaAh6nEALw_wcB&gclsrc=aw.ds (195)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.shoulderunit.co.uk/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B_3RUi0vYybSD	Not recorded	Not recorded	2	Public	Often imaging tests are used to determine the location, extent and nature of any bone spur or tendon tear. Examples include x-rays, ultrasound scans or magnetic resonance (MRI) scans (Rotator Cuff Disease).

RxXmH-E_Hhn5eFhsIEb-C9s-wVEfo9q9WfKMNWgS0aAnT7EALw_wcB (196)					Diagnosis is usually straightforward but requires an X-ray (Osteoarthritis). MRI scans can determine the exact site and extent of the tear and its influence on tendons and muscles (SLAP Tear). Assessment of shoulder pain depends largely on a careful history of the onset, duration and location of the pain, and its relation to sleep, rest or activity. It may also be associated with other symptoms. Detailed physical examination and selective imaging such as x-rays, ultrasound, CT or MRI scans may be required to establish a precise diagnosis (Shoulder Assessment).
https://www.izito.co.uk/ws?q=shoulder%20pain%20treatments&asid=iz_uk_2_010_010&mt=b&nw=g&de=c&ap=1o3&ac=1913&gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9XTyfxN9xDlvoL6qi_U5499ojYfNUp7K8pCbTPooUuPwJ7W2lHMp8aAn5_EALw_wcB (197)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://patient.info/bones-joints-muscles/shoulder-pain-leaflet (198)	Not recorded.	November 2018	4	Public	The diagnosis of frozen shoulder is usually made by a doctor's examination. You may also have an X-ray or an MRI scan of your shoulder joint. The hallmark of frozen shoulder is that an X-ray should be normal (Frozen Shoulder). Your doctor may be able to find out what is causing your rotator cuff disorder just by talking to you and examining your shoulder. Occasionally, your doctor may suggest an X-ray of your shoulder to rule out other causes of shoulder pain. They may refer you for more detailed investigations such as

					an ultrasound scan or a magnetic resonance imaging (MRI) scan (Rotator Cuff). Your doctor can often diagnose osteoarthritis (OA) based on your age, your typical symptoms and examination of your affected joints. Tests such as X-rays or blood tests are usually not needed. However, sometimes your doctor may suggest X-rays or other tests if they are uncertain about the diagnosis and want to exclude other problems (Osteoarthritis).
https://www.shoulderunit.co.uk/services/shoulder-pain/ (199)	Not recorded	Not recorded	2	Public	Assessment of shoulder pain depends largely on a careful history of the onset, duration and location of the pain, and its relation to sleep, rest or activity. It may also be associated with other symptoms. Detailed physical examination and selective imaging such as x-rays, ultrasound, CT or MRI scans may be required to establish a precise diagnosis.
https://www.highgatehospital.co.uk/gp-news/experiencing-shoulder-pain/ (200)	February 2019	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.nhsinform.scot/illnesses-and-conditions/muscle-bone-and-joints/self-management-advice/shoulder-problems (201)	Not recorded	February 2020	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.nwbh.nhs.uk/shoulder-pain (202)	Not recorded	Not recorded	3	Public	Diagnosis is usually made from the patient's history and an examination, without the need for special investigations. An X-ray may be performed, but this is unusual for frozen shoulder (Frozen Shoulder). Diagnosis is usually made from the patient's history and a simple examination, without the need for special investigations. An X-ray or ultrasound scan may be performed if there is uncertainty about the diagnosis or if symptoms fail to settle with a course of physiotherapy (Subacromial Pain Syndrome).

https://ahpsuffolk.co.uk/Home/SelfHelp/ShoulderPain.aspx (203)	Not recorded.	March 2020	3	Public	In traumatic cases may be referred to orthopaedics for investigations including imaging and sometimes surgical repair (Rotator Cuff Tear). In some cases ultrasound or magnetic resonance imaging can be useful, these are only considered if it will guide treatment (Rotator Cuff Tendinopathy). X-ray can pick up calcium deposits as can ultrasound scans which make it easier to assess the size of the deposit in all directions (Calcific Tendonitis). Generally, not indicated, if symptoms are not improving with conservative measures after 3 months a steroid injection may be considered (Biceps Tendonitis). X-ray can assess the level of Osteoarthritis. X-ray to rule out bony pathology (e.g. dislocation or OA), should come back normal (Frozen Shoulder). With Injury - X-ray, usually needs relocating in A&E; Without Injury - normally does not require investigations but physiotherapy can help improve stability and muscular control (Shoulder Dislocation). If there has been trauma with an increased prominence of the ACJ and significant reduction in shoulder movement then a fracture or dislocation may be suspected, in this case an x-ray is likely to be needed via A&E to rule out these pathologies (Collarbone Pain). In severe cases should patients fail to respond to 6 months of conservative management via Physiotherapy the Physiotherapist will refer on to Orthopaedics for further investigation and possible invasive treatment (Collarbone Pain).

https://www.hacw.nhs.uk/shoulder-pain/ (204)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
http://www.southend.nhs.uk/media/188256/shoulderpainincexcercise.pdf (205)	November 2012	Not recorded	3	Public	A diagnosis is based on your symptoms and an examination of your shoulder, but may sometimes require x-rays, ultrasound or magnetic resonance imaging (MRI) scans. X-rays can be useful in certain cases, but they won't show problems in the soft tissues around the joint – the muscles, tendons or cartilage. An x-ray may show minor changes, especially in the acromioclavicular joint, but these changes are quite common and may not be the cause of the pain. An x-ray may also show a deposit of calcium in the tendons which can sometimes cause inflammation and pain (acute calcific tendinitis). An ultrasound scan can be very helpful, it allows thickening in the soft tissues of the shoulder to be seen and can also detect fluid and damage to tendons and muscles. It may also show larger tears in the rotator cuff, although an MRI scan is more reliable in assessing rotator cuff problems Ultrasound or MRI can also be helpful in confirming a diagnosis of painful arc in impingement syndrome. Magnetic resonance imaging (MRI) scans may be carried out if your doctor suspects a complex problem in the shoulder, or if you're likely to need specialise treatment. An MRI scan allows the soft tissues to be seen and is particularly helpful identifying tears in the rotator cuff tendons. Occasionally a contrast medium is injected into the shoulder medium is injected into the shoulder before the san is carried out – this works a bit like a dye and allows more detail to be seen.
https://www.sportsinjuryclinic.net/sport-injuries/shoulder-pain (206)	May 2018	Not recorded	2	Public	Imaging studies such as x-ray, MRI or CT Scan can confirm the diagnosis, and rule out a fracture (Rotator Cuff Strain). An X-Ray or MRI may be used to identify what is causing the impingement (Shoulder Impingement).

					An x-ray will confirm the fracture (Clavicle Fracture). An MRI scan can confirm the diagnosis and identify any tearing of the tendon (Rotator Cuff Tendinopathy).
https://www.orthteamcentre.co.uk/?gclid=Cj0KCQiAsvTxBRDkARIsAH4W_j_aMx0Pu4YQP8LW2NmY79aSCzu_zdBvdEl2pSTfZLI303LuGZwVp-caAiT5EALw_wcB&gclsrc=aw.ds (207)	Not recorded	Not recorded	2	Public	Your consultant will examine you and ask you to demonstrate certain movements to check how well your shoulder is working. You might need some additional tests such as an x-ray, an ultrasound scan or a magnetic resonance imaging (MRI) scan (Shoulder Pain).
https://claiminjurynationwide.co.uk/slp/shoulder-injury?src=google&kw=shoulder%20injurysb&gclid=Cj0KCQiAsvTxBRDkARIsAH4W_j-4qZYf6yYvnHjz6HwMeDGunI19GjCW7O-VM3WkIkwpJvoyk7Xh-iYaAp9oEALw_wcB (208)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://patient.info/doctor/shoulder-pain-pro (209)	Not recorded	June 2015	4	Clinicians	Blood tests and radiology such as CXR are generally only necessary if there are 'red flag' symptoms/signs. Ultrasonography is the preferred imaging technique for the shoulder. Plain X-rays rarely help except to confirm shoulder dislocation and shoulder arthritis. Magnetic resonance arthrogram is useful in shoulder instability.

					If referred neck pain is suspected then cervical spine X-rays may be helpful but the diagnosis is usually clinical. X-rays are usually only necessary if the presentation is atypical or the patient is not responding to treatment. X-rays are commonly normal (Frozen Shoulder). Plain radiographs are the initial choice. OA of the AC joint cannot be reliably diagnosed by X-ray as, although degeneration may be revealed, similar findings can be seen in asymptomatic individuals. CXR or full clavicle views may be needed in some cases (ACJ). This is a clinical diagnosis and investigation is not routinely required. However, investigations may occasionally be useful - for example, when pain is severe, the diagnosis is in doubt or functional limitation is marked (Biceps Tendinopathy). Ultrasound is the examination of choice. Soft tissue ultrasound may help to improve localisation prior to local steroid injection (Biceps Tendinopathy). Even if the diagnosis of dislocation is clinically obvious, the shoulder should be x-rayed to exclude an associated fracture. The exception may be a recurrent dislocation with minimal trauma (Shoulder Dislocation). Plain X-ray may be used when there is a suspicion of neoplasia. The demonstration of spurs, calcification or changes of osteoarthritis is unlikely to help management (Biceps Tendinopathy). MRI scan can demonstrate the whole course of the biceps tendon (including the intra-articular tendon and related intra-articular pathology). However, it is not appropriate or cost-effective for routine use. It is indicated after unsuccessful rehabilitation or where there is suspected rotator cuff or labral tear injury (Biceps Tendinopathy).

https://www.cancerresearchuk.org/about-cancer/cancer-chat/thread/shoulder-pain-becomes-breast-cancer (210)	September 2016	Not recorded	4	Public	My mum has had shoulder pain over the last few months which she has been to the doctors about numerous times. They sent her for X Ray's and said that they couldn't see what was wrong but suspected arthritis. The pain was getting worse and has now spread under her arm so she went back again. The nurse felt her breast and sent her for a mammogram. I had a painful left shoulder for six months and was treated for arthritis then I went for my annual mammogram and it was discovered that I had a large tumour in my left breast I had to have a mastectomy and afterwards to take hormone inhibitor tablets for five years needless to say my shoulder pain disappeared so I think any pain in the shoulders should be investigated more and not dismissed as arthritis I am now 77and hope to live for another ten years or more on the new treatment
https://www.topdoctors.co.uk/medical-articles/why-does-my-shoulder-hurt-the-many-causes-of-shoulder-pain (211)	February 2019	February 2019	2	Public	There is generally loss of active and passive range of motion and can sometimes be confused with a frozen shoulder in the absence of an X-ray (Osteoarthritis). Treatment such as medication, guided injections, and physical therapy are the mainstay of management. In some cases symptoms do not improve, and the doctor or specialist may send you for tests such as an MRI or ultrasound scan to see if a rotator cuff tear is present, and if so where and how big it is (Rotator Cuff). If the physical examination is not conclusive, imaging tests such as an ultrasound, X-ray or MRI may be used (Rotator Cuff). Tests to diagnose shoulder tendonitis are as follows: ● Ultrasound scan ● X-ray ● MRI scan ● Computed tomography scan (CT) These tests and the detailed study of the patient's medical history usually provide an accurate diagnosis.

https://www.popsugar.co.uk/gdpr-consent?destination=https%3A%2F%2Fwww.popsugar.co.uk%2Ffitness%2FWhy-Does-My-Shoulder-Hurt-When-I-Run-46471666 (212)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.
https://www.amazon.co.uk/s?k=shoulder+pain+relief&adgrpid=52866675013&gclid=Cj0KCQiAsvTxBRDkARIsAH4W_j_5uDFlLe4olydo9-yqTYaJujMZRUxuYe4C5VORm9wlM2P2O2gCzfMaAqbkEALw_wcB&hvadid=259095991427&hvdev=c&hvlocphy=9046265&hvnetw=g&hvqmt=b&hvrand=3819357589190251425&hvtargid=kwd-487953133432&hydadcr=28176_1821090&tag=googhydr-21&ref=pd_sl_5y58ppobh8_b (213)	Not recorded	Not recorded	N/A	Public	No recommendations or information on the use of diagnostic imaging.

3.2.4 Quality Appraisal

There were five (n = 2 were related to LBP, n = 3 for knee pain) websites with clear and substantial differences to the recommendations regarding the use of imaging provided by other websites. Each of these five (185,196,199,206,207) websites were categorised by the DISCERN Tool **(Tables 7-9)** as being a source of information with serious limitations and in turn deemed to be not a useful source.

Therefore, it was clear that to be able to understand whether website quality was the reason that explained the clear and substantial difference in recommendations, that determining the quality of the websites that had made consistent recommendations would be required. This involved appraising all websites included in this review that had made recommendations with the DISCERN Tool, representing a deviation from protocol **(Tables 7-9)**.

Of the 48 websites that provided recommendations or information on the use of diagnostic imaging, 16 (n = 5 were related to LBP, n = 6 for knee pain and n = 5 for shoulder pain) were categorised as having serious limitations and in turn, not a useful resource. It would appear that clear and substantial differences related to imaging content may be explained by lower website quality, but not exclusively.

3.2.5 Narrative Synthesis

Following familiarisation, initial codes were labelled across the entire data set to identify areas across the data that were relevant to the research aims. These codes

were tagged by using a combination of coloured and highlighted text. An example of this is provided in **Appendix 11.**

There were 20 initial codes:

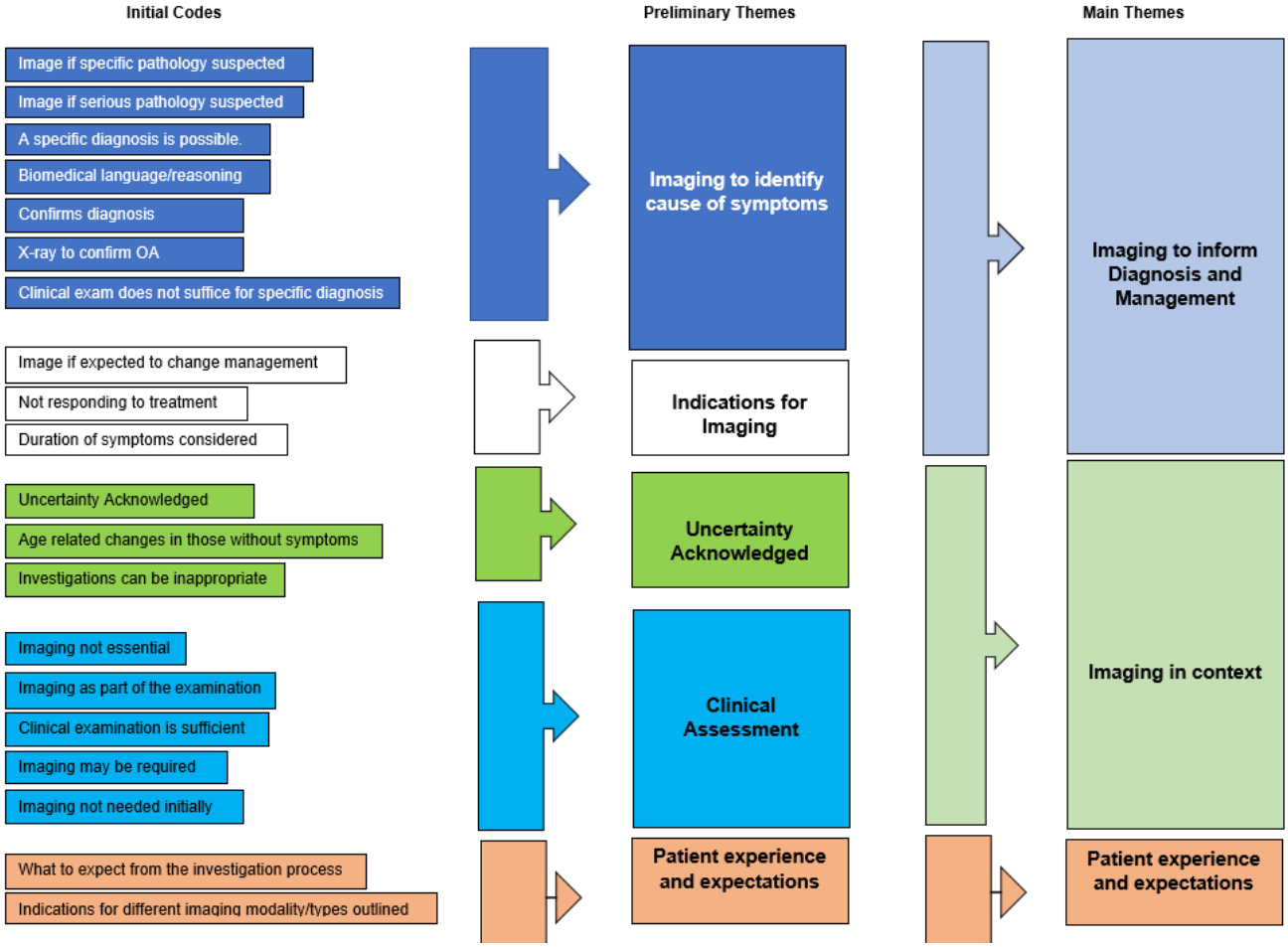
- Uncertainty acknowledged
- Age related changes in those without symptoms
- Image if expected to change management
- Indications for different imaging modality/types outlined
- What to expect from the investigation process
- Imaging not essential
- Imaging as part of the examination
- Not responding to treatment
- Clinical examination is sufficient
- Imaging may be required
- Duration of symptoms considered
- Image if serious pathology suspected
- Clinical exam does not suffice for specific diagnosis
- A specific diagnosis is possible.
- Imaging not needed initially
- Confirms diagnosis
- Biomedical language/reasoning
- X-ray to confirm OA
- Image if specific pathology suspected
- Investigations can be inappropriate

These initial codes were then reviewed and refined where commonality existed in order to provide more meaning to the data. This step resulted in the refinement of the 20 initial codes into five preliminary themes (**Figure 4**).

To complete the synthesis, the preliminary themes were reviewed with reference to the coded data. This resulted in the refinement of the five preliminary themes into three main themes: ‘Imaging to Inform Diagnosis and Management’, ‘Imaging in Context’, and ‘Patient experience and expectations’.

These three main themes were reviewed with reference to both the coded data and the entire data set. This step in the process resulted in no further refinement, with the following themes identified within the written information of public-facing websites regarding imaging for LBP, knee, and shoulder pain.

Figure 4: Themes identified from the recommendations or information provided within public-facing websites on the use of diagnostic imaging for LBP, knee, and shoulder pain.



3.2.5.1 Imaging to Inform Diagnosis and Management

The role of diagnostic imaging to inform diagnosis and management is a clear theme across the written information and recommendations within public-facing websites. These recommendations were framed within the context that a diagnosis is possible, and that imaging is the gold standard to both inform and confirm diagnosis. This was particularly relevant where either a serious (such as cauda equina syndrome) or specific (such as a fracture) pathology was suspected. In addition to the use of imaging in this context, recommendations also indicated that imaging should be used where symptoms have persisted despite treatment and the results of the imaging expected to change management.

> *"You'll only usually be sent for tests if your pain lasts for longer than six weeks, if you have had an injury or blow to your back, or if your GP suspects that there may be an underlying cause for your pain."* – ***LBP***

3.2.5.2 Imaging in Context

Aligned to, but in slight contrast to the above theme, the second theme across the recommendations relates to the use of diagnostic imaging in context. These recommendations acknowledged the uncertainty underpinning the use of imaging, in particular the prevalence of changes seen on imaging in those populations without symptoms. Within such a context, the possibility of misuse of diagnostic imaging is outlined with reference to consideration of whether imaging is required, and if

obtained, should be interpreted in the context of the clinical presentation, rather than in isolation.

> *"There is a significant false positive rate from MRI of the knee. Abnormal findings have been reported in healthy individuals with no knee symptoms: 16% have evidence of meniscal tears, increasing to 36% for people aged over 45."* – ***Knee Pain***

3.2.5.3 Patient experience and expectations

Where an investigation is required, what to expect from the process and what imaging modality to expect is described. In particular, what to expect from the process is outlined for the less common imaging modalities such as DEXA (131) and CT Scan (142). There was consistency with regard to x-ray being utilised as a first-line investigation if the suspected diagnosis is related to the bone i.e. fracture with a CT scan reserved as a second-line investigation following x-ray if further detail is required.

Where a suspected diagnosis is not related to the bone i.e. soft tissue injury, there was again consistency in that for those with LBP or knee pain an MRI scan is the investigation of choice to both assess the soft tissues but also to rule out serious pathology. Whilst for the shoulder, an ultrasound scan (USS) was recommended as the first-line investigation with an MRI scan reserved as a second-line investigation following USS, should further detail be required.

"An ultrasound scan can show swelling, as well as damage and problems with the tendons, muscles, or other soft tissues in the shoulder. It uses high-frequency sound waves to examine and build pictures of the inside of the body." – ***Shoulder Pain***

"If your doctor thinks you may have osteoporosis, they may suggest you have a DEXA (dual energy x-ray absorptiometry) scan to measure the density of your bones. The scan is readily available and involves lying on a couch, fully clothed, for about 15 minutes while your bones are x-rayed." - ***LBP***

3.3 Discussion

The aim of this scoping review was to identify and map the content of public-facing websites with respect to the use of diagnostic imaging for adults with LBP, knee, and shoulder pain, fulfilling objective **ii** of this thesis (**see 1.4**). To the author's knowledge, this represents the first review of its kind with reference to mapping public-facing websites and reviewing the written information and recommendations for use of diagnostic imaging within these. This review identified three main themes that when combined, outline the key messages contained within public-facing websites regarding the use of diagnostic imaging for LBP, knee, and shoulder pain: (i) imaging to inform diagnosis and management; (ii) imaging in context; and (iii) patient experience and expectations.

There were five (n = 2 related to LBP, n = 3 for knee pain) websites with clear and substantial differences to the recommendations provided by other websites. These

five websites each demonstrated serious limitations and in turn were considered to not be a useful source of information. However, other websites for LBP (n = 3) and knee pain (n = 3) which were also identified as having serious limitations, provided recommendations that were consistent with those provided by websites deemed useful and appropriate. None of the included websites for shoulder pain (n=?) made recommendations regarding imaging that were clear and substantially different. However, five of the included shoulder websites demonstrated serious limitations and were considered to not be a useful source of information. Clear and substantial differences related to imaging content may be explained by lower website quality, but not exclusively. Other factors not explored as part of this review, such as credibility, commerciality, currency or comprehensiveness may explain this difference.

The findings of this scoping review suggest that the majority of written information and recommendations within public-facing websites are consistent with the recommendations within CPGs that inform UK clinical practice. The first scoping review of this PhD (Chapter 3) (214) demonstrated that the recommendations contained within CPGs do not justify the increase in imaging rate. The review concluded that routine use of diagnostic imaging should be discouraged and reserved for clinical circumstances where there is a suspicion of specific or serious pathology, or where the person is not responding to initial non-surgical management and the imaging result is expected to change that person's clinical management (214).

With the use of diagnostic imaging increasing within primary and intermediate care in the UK, patient expectations or beliefs have been suggested to be one factor that might explain the rise in imaging requests (15,110,215). It has been shown in the UK that 96% of people are satisfied with the health-related information that they have seen on the internet, with 61% of people obtaining health information via the internet over a 12-month period (216). For those with shoulder pain (217), more people utilised internet searches (52.5%) to obtain health-related information than consulting their physiotherapist (49.2) or their family and friends (14.2%). Given the consistency between public-facing website recommendations and CPG recommendations, and the extent to which the internet is used by the public and patients to obtain health-related information, the written information contained within the public-facing websites does not appear to be a potential reason for changing patients' expectations and increased demand for diagnostic imaging in the UK. Future research should look to understand the reasons for requesting diagnostic imaging for MSK pain conditions affecting the lower back, knee, or shoulder, from the perspective of the referring clinician and patients.

The written information contained within public-facing websites, being consistent with CPG recommendations, is not a constant finding within the wider literature. A systematic review of the credibility, accuracy and comprehensiveness of treatment recommendations for LBP contained within public-facing websites demonstrated that the majority of websites did not demonstrate credibility, lack comprehensiveness and provide a high proportion of inaccurate recommendations when compared to those with CPGs (218). The difference in consistency found between website information and CPG recommendations within the systematic review by Ferreira et al. (2019)

and the current scoping review, may be explained by the difference in area of research focus as well as the methods used. The systematic review by Ferreira et al. (2019) focused on recommendations for treatment within CPGs, rather than recommendations for use of diagnostic imaging. With regard to methods used, the search strategy by Ferreira et al. (2019) was developed by the research team, rather than co-produced through PPIE. The current scoping review limited websites to those that were either UK-based or NHS affiliated whilst the systematic review included websites that were based in five major English-speaking countries, with the majority of included websites being based in the United States. Further, whilst the current scoping review included public-facing websites for LBP, knee, and shoulder pain, the systematic review included websites for LBP only (218).

3.3.1 Strengths and Limitations

To date, this represents the first review of its kind with reference to mapping public-facing websites and reviewing the written information and recommendations for use of diagnostic imaging within these. The strengths of this scoping review include that it was conducted in accordance with good practice as recommended for the conduct of scoping reviews (53) and the methods have been reported transparently, allowing for replication. This includes the a priori publication of the protocol and outlining where a warranted protocol deviation occurred, and the reasons behind this.

The involvement of a PPIE group to design the search strategy should be considered a strength within the context of this review. However, the PPIE group may not have been the most representative of the general public in terms of cultural diversity and an average age of 58, which may in turn have influenced the design of the search

strategy, influencing the subsequent results of the review. Future PPIE meetings should look to maximise diversity, reflective of the population of interest in order to overcome this limitation.

Aligned to this point, within the PPIE meeting, video sources of information were not discussed with the subsequent focus of the review being on written information contained within the public-facing websites. The limitation of this is acknowledged in that video-based content is becoming increasingly popular and utilised (219). Future research should look to review messages contained within publicly available video-based content, including that contained within social media to understand the recommendations within such a medium to the public regarding the use of diagnostic imaging.

3.4 Conclusion of this review

This review identified 48 public-facing websites that provided written information or recommendations for the use of diagnostic imaging in adults with LBP, knee, or shoulder pain. The written information or recommendations contained with the websites were largely consistent. The key messages contained within public-facing websites regarding the use of diagnostic imaging outlined what patients should expect in terms of imaging modality and the experience when undergoing lesser common modalities. Where imaging is used, it should be to inform diagnosis and management within the context of the clinical presentation, rather than in isolation.

This chapter presented the second of two scoping reviews. This scoping review summarised the recommendations within public-facing websites related to the use of diagnostic imaging. The recommendations made by CPGs and the written information contained within public-facing websites does not appear to justify the increase in imaging rates seen in the UK. In the next chapter, the background and methods underpinning the qualitative investigation are presented. This qualitative investigation explores the reasons for requesting diagnostic imaging from the perspective of the referring clinician and patients.

Chapter 4: Understanding the use of diagnostic imaging in primary and intermediate care for MSK pain affecting the lower back, knee, and shoulder: a qualitative investigation.

Summary

This chapter presents the background and methods for the qualitative investigation within this thesis. This qualitative investigation explores the use of diagnostic imaging for non-traumatic, MSK pain conditions affecting the lower back, knee, and shoulder from the perspective of both patients and referring clinicians. Participants were purposefully sampled from an NHS provider of community MSK services within primary and intermediate care settings. The findings and discussion of this investigation are presented in Chapter 5 (patients' perspective) and Chapter 6 (clinicians' perspective). These three chapters have been reported in accordance with the standards (**Appendix 14**) for reporting qualitative research (SRQR) (220)

This qualitative investigation was supported by a Scheme B research grant (**Appendix 13**) awarded by the Chartered Society of Physiotherapy Charitable Trust (CSPCT) – PRF/19/BO5

4.0 Background

The findings from the scoping reviews (**Chapter 2 and 3)** suggest that the information and recommendations available for clinicians (CPGs) and patients

(public-facing websites) may not be contributing to the increased use of diagnostic imaging observed in the UK.

Whilst emerging evidence suggests that patients believe that imaging aids diagnosis and treatment planning, and that this may be influenced by health care professionals, there is not enough evidence to confirm one way or another (221). Previous studies that have sought to understand beliefs about the role of imaging have largely centred around LBP, with the majority utilising quantitative methods such as surveys (221). There is little qualitative evidence exploring this phenomenon, with those studies that have been published, being set in a non-UK context. The insight from these studies suggest that patients feel imaging is necessary, provides greater insight into diagnosis than clinical examination, and can provide reassurance in the context of severe symptoms (221).To date, as far as I am aware, there are no qualitative studies seeking to understand patient or public beliefs around the use of diagnostic imaging in LBP that have been undertaken in a UK setting.

Patient beliefs regarding the role of imaging in shoulder or knee pain has not been specifically explored. There are no qualitative studies that have explicitly sought to develop an understanding of public or patient beliefs regarding the role of imaging as their research question. However, insight is provided within published qualitative studies that have wider aims, usually to understand patient expectations or the impact of living in pain, where the role of imaging is then discussed (17,222–225) For those with shoulder pain (17,223), imaging is referred to as authorative for diagnosis,

particularly where uncertainty exists, and patients often express regret of not being scanned sooner. The impact of this is that patients often understand their symptoms through a biomedical lens. For those with knee pain (222,224,225), similar insight is gained around the use of imaging being perceived as authorative for diagnosis, with imaging findings being highly influential in how patients under their symptoms, whilst also having the potential to both reassure but also to guide prognosis. Whilst this insight is useful, with the role of imaging not being the phenomenon of interest, the understanding is limited to a superficial level. It is not known where these beliefs develop from, or how they influence subsequent management. Therefore, there is a need to develop this understanding further to gain insight to support appropriate imaging use.

Recommendations for imaging within guidelines and public-facing websites, do not explain the increased use of imaging seen in the UK. With imaging use increasing (15,25), there is a clear need to understand the reasons underpinning the use of imaging from the perspective of both patients and clinicians. This chapter presents the methods used to undertake a qualitative investigation designed to develop a rich understanding of imaging use for MSK pain conditions affecting the lower back, knee, and shoulder in NHS primary and intermediate care.

4.0.1 Objectives of the qualitative investigation

Primary Objective

To understand the reasons for requesting diagnostic imaging for MSK pain conditions affecting the lower back, knee, or shoulder, from the perspective of the referring clinician and patients.

Secondary Objective

To understand how the imaging findings are used, including how scan findings might guide treatment decision-making and/or referral for further clinical opinion.

4.1 Methods

Ethical approval was obtained from NHS Research Ethics Committee (Wales REC 7) and the Health Research Authority on the 3rd March 2021 (Ref 21/WA/0061) and the Health and Education Faculty Research Ethics and Governance Committee, Manchester Metropolitan University on the 10th March 2021 (Ref 25489) **(Appendix 15).**

Key ethical considerations

There were no significant anticipated or expected risks to the participants during data collection. All participants would provide informed consent following receipt of, and consideration of appropriate information related to the research. This is explored in more detail in **5.1.3.2**.

Participants were recruited from Connect Health services, a national provider of NHS services. For patients, it was highlighted that the interview was part of the research study and not related to their clinical care. If any clinical issues arose during the interview, or if the patient had any questions related directly to their clinical care; they were signposted to the appropriate member of the clinical team. For clinicians, they

were informed that the interview was confidential and not related to their clinical performance or capability. Insight provided regarding their use of imaging would not be shared with their manager or clinical supervisor, with confidentially maintained through use of pseudonyms and not revealing the Connect service location in which they work in either the interviews, analysis, or write up.

The ethical implications of my role as an employee, line manager, supervisor and clinician within Connect Health were considered during the development of the research protocol. Give my role, this would constitute adopting an insider position within the context of this qualitative investigation. My role as an insider was considered ethically in circumstances where I had recruited patients into the study as the clinician responsible for their care, as well as my role with reference to the clinicians. An insider is defined as a researcher who shares a similar background to the population, they are studying (226). As a senior leader in Connect and accountable for the quality of the MSK services within Connect, this may introduce tension for the clinicians when asked to speak openly and honestly around their practice. To account for this insider status in my role as the interviewer, further mitigation was implemented by ensuring the supervisor team had access to topic guides, and interview recordings which were reviewed and then discussed during the regular supervisory meetings.

Whilst no significant risks were anticipated, should the participant have found the interview upsetting or distressing, they were aware that the interview could be paused and that they could take a break. All participants were aware that they were

not expected to answer every question should they not wish to. The interview would recommence when the participant was ready to do so, and they were aware that the interview could be discontinued if they wished.

There were no direct benefits however, by participating in this research study, participants were made aware that they would be contributing to knowledge creation and helping to improve care quality. To thank and compensate participants for their involvement and time, they were provided with a £30 Amazon voucher. This was enabled through the CSPCT research grant.

With the interviews being conducted virtually, there was no direct risk to the interviewer.

4.1.1. Study Design

This qualitative investigation aimed to understand why imaging is requested, and how the imaging findings are used. To achieve these objectives, quantitative methods such as a survey could have been utilised, but this was felt insufficient to fully meet the specified aim. There would be advantages to undertaking a survey that include practical aspects such as time, as well allowing comparison with other surveys that had been completed in different countries (227), or different time periods (228). However, given the need for in-depth exploration, qualitative methods would be more suitable to achieve the objectives.

As such, a qualitative study using semi-structured interviews with patients and clinicians in NHS primary and intermediate care was conducted. A qualitative study aims to implement an inquiry process that understands and explores the phenomenon of interest through the generation of non-numerical data, allowing probing for greater detail, the ability to explore unanticipated areas more readily, as well as the opportunity for reflexivity (229,230). Given the research objectives both relate to developing an understanding of a phenomenon, undertaking a qualitative study utilising semi-structured interviews would facilitate this. A semi-structured interview is a social interaction based on a conversation that attempts to understand the world from the perspective of the participants enabling a desire to understand the meaning behind the data (129).

This qualitative investigation was conducted in two phases, one with patients alone and one with clinicians alone. This approach was chosen given that the reasons for requesting imaging, and how the findings would be utilised in the care journey, would be both complex and likely different from the perspective of the patient and the clinician. Progressing in two phases enabled this complexity to be explored in depth with participants. The findings were not integrated during the research process, in alignment with a multi-methods design, as different research questions were being addressed from different perspectives (46). One phase was with patients that had either been seen in general practice (primary care) or within an MSK service (intermediate care). The second phase with physiotherapists that worked in either primary care (as a First Contact Physiotherapist, often referred to as an ‘FCP’) or intermediate care as an Advanced Physiotherapy Practitioner (APP)/Consultant Physiotherapist. This role of clinician was chosen as the use of diagnostic imaging

within physiotherapy practice is typically reserved for those that can demonstrate competence at an advanced clinical level.

4.1.2 Study Setting

To aid successful completion of this study during COVID-19 restrictions, all stages of the study were completed virtually either by telephone, or video conferencing technology (via Teams) between April 2021 and May 2022.

Patients and clinicians were approached through Connect Health (Connect) where I was employed as a Consultant Physiotherapist. Connect is the largest specialised, independent provider of NHS MSK services, geographically spread across primary and intermediate care within England, seeing more than 350,000 patients per year. Connect services are provided via an NHS Standard Contract and are a recognised NHS provider delivering services across 26 Clinical Commissioning Groups (CCGs) across the Northeast, Yorkshire, Midlands, London, and the Southeast. Permission was granted from Connect to be a recruitment site **(Appendix 16)**. The study was initially introduced virtually to clinicians with a subsequent recording made available to minimise the need for a site visit. This presentation was delivered virtually, outlining the background to the study, the aims, eligibility criteria and contact details of the research team. Further, a recording of the presentation was made available for circulation within the clinical teams of the participating sites. Interviews were conducted via telephone or video (based on participant preference) for both patients and clinicians. Therefore, there were no fixed locations within this investigation and allowed both patients and clinicians to participate from across England.

4.1.3 Participants

The inclusion criteria for patients were:

- Adult (≥18 years)
- Presenting in NHS primary or intermediate care with non-traumatic LBP, knee, or shoulder pain and have either:
    - Been referred for a scan
    - Indicated an expectation for a scan
    - Undergone a scan
- Able to understand English, independently or with support from an interpreter.
- Able to undertake an interview by remote/virtual means (telephone/video).

The inclusion criteria for clinicians were:

- Physiotherapists working within primary (FCP) or intermediate care (APP/Consultant Physiotherapist).
- Working with an MSK caseload that included LBP, knee, or shoulder pain.
- Able to undertake an interview by remote/virtual means (telephone/video).

The exclusion criteria for patient participants were:

- Patients who were unable to give full informed consent.
- Patients for whom serious pathology was suspected at the time of FCP or APP/Consultant Physiotherapist assessment.

The exclusion criteria for clinician participants were:

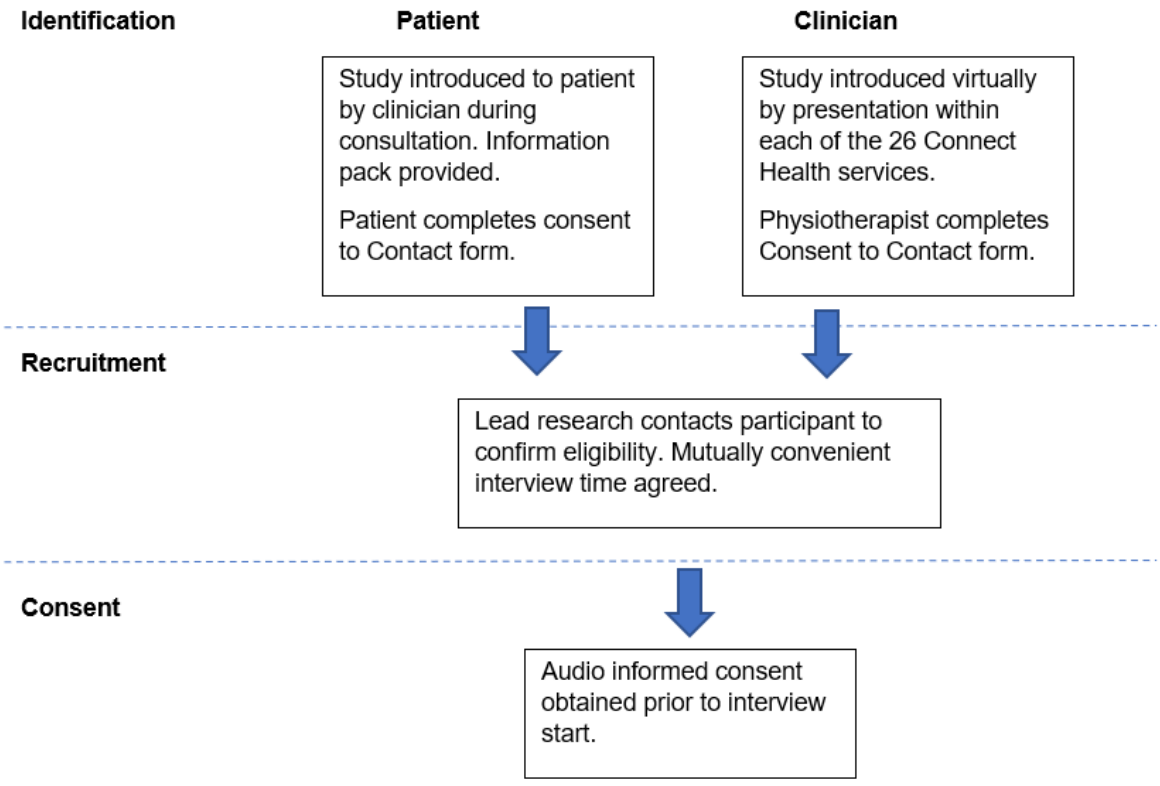
- Physiotherapists who work solely within secondary care.
- Physiotherapists that were unable to request diagnostic imaging (MRI, USS, X-ray) as part of their scope of practice.

Physiotherapists were the only professional group within the clinical sample as a condition of the CSPCT funding.

4.1.3.1 Recruitment

The recruitment pathway is summarised in **Figure 5.**

Figure 5: An overview of the participant recruitment pathway



Identification - Patients

Purposeful sampling is one sampling strategy within qualitative studies and involves the selection of individuals by characteristics that can inform understanding of the research objectives through phenomena that are central to the study aims. Patients were purposefully sampled with respect to:

- regional pain complaint – LBP, knee pain or shoulder pain
- not been referred for an investigation but had indicated an expectation.
- been referred for an investigation.
    - the type of investigation i.e. MRI, USS, X-ray
- having attended an intermediate care appointment with an investigation already completed within primary care for their existing presentation.

Patients were introduced to the study during clinical appointments whereby clinicians, familiar with the aims of the study identified those that were potentially eligible as per the sampling framework. To ensure the sample was purposive as opposed to convenience, as the research progressed there was communication with clinicians from AC regarding characteristics of interest. This was achieved through regular email updates to the Connect Health clinicians regarding the status of the research.

The patient journey to this point was variable between sites and care setting. For those in primary care, the patient had attended an appointment with the FCP whereby a presenting regional pain complaint of LBP, knee, or shoulder pain was established. Within this consultation the patient may have been referred for a scan or indicated an expectation for a scan (in rare circumstances, the patient may have undergone a scan), at which point the FCP subsequently introduced the study to the patient.

For those in intermediate care, the patient had attended an appointment with an APP/Consultant Physiotherapist whereby a presenting regional pain complaint of LBP, knee, or shoulder pain was established. Within this consultation the patient may have been referred for a scan, indicated an expectation for a scan or the patient may have undergone a scan, at which point the clinician subsequently introduced the study to the patient.

An information pack was provided to the recruiting clinicians (i.e., those that would identify patients for recruitment intro the patient interviews) consisting of a patient information sheet **(Appendix 17)**, consent to contact form **(Appendix 18)**, consent form **(Appendix 19)**, and contact details of the research team. Once the study had been introduced to the patient, if they were interested in discussing the study further with the lead researcher, they were provided with the information pack and asked to sign a consent to contact form; this form included a section for the recruiting clinician to complete which confirmed the patient's eligibility and which specific inclusion criteria the clinician felt the patient matches.

Given clinical practice during recruitment was adopting a 'virtual first' approach and patients may have had their entire care episode provided via either telephone or video, the above information pack was also available to clinicians electronically. In such circumstance, once the study had been introduced to the patient, if they were interested in taking part in the study, they were provided with the e-information pack.

Once the consent to contact form was received, the patient was contacted by the lead researcher to discuss the study, answer any questions, confirm eligibility, and gain informed consent.

Identification – clinicians

To identify physiotherapists, the study was introduced at each participating site through an initial presentation (**Appendix 20**). During this presentation, a consent form **(Appendix 21)**, participant information sheet **(Appendix 22)**, and consent to contact form **(Appendix 23)** was provided.

If a physiotherapist was interested in participating in the study, they completed a consent to contact form. With the presentation being delivered virtually, the consent to contact form was provided in in an electronic format using Microsoft Forms. They were then contacted by the lead researcher to discuss the study, answer any questions, confirm eligibility, and gain informed consent.

4.1.3.2 Consent

Consent – patients

Patients that were interested in participating and were eligible, were required to provide audio informed consent **(Appendix 24)**. The patient was contacted to have the study explained in more detail and given the opportunity to ask questions. Eligibility was confirmed during this conversation. Following this, if the patient was still interested and willing to participate in the study, a mutually convenient interview

time was scheduled, and they were added to the participant log. Interviews were held and recorded either via telephone or video-based online communication platforms (dependent on participant preference). The Microsoft Teams platform was used for video-based interviews. Each item on the written consent form was read out and the patient asked to confirm agreement with each statement as a means of confirming informed consent. Participants had the right to withdraw from the study without affecting their care.

Consent – clinicians

Physiotherapists that were interested in participating and were eligible, were required to provide audio informed consent. The physiotherapist was contacted to have the study explained in more detail and given the opportunity to ask questions. Eligibility was confirmed during this conversation. Following this, if the physiotherapist was still interested and willing to participate in the study, a mutually convenient interview time was scheduled, and they were added to the participant log. Interviews were held and recorded either via telephone or video-based online communication platforms (dependent on participant preference). The Microsoft Teams platform was used for video-based interviews. Informed consent from the clinician was obtained in a similar process to that described in **Appendix 24.** Participants had the right to withdraw from the study without affecting their care.

4.1.4 Sample

It was initially proposed that up to 21 patients and 16 clinicians would be required. The estimated number of participants was based upon other qualitative studies of

this kind where it was reported that saturation had been reached with similar numbers to those anticipated (20). The term ‘saturation’ is used widely in qualitative research, with inconsistent interpretation and application, for example, whether saturation relates to codes, data, or theory are used interchangeably (231). There have been attempts to generate models that allow for a priori calculation of sample size (232) and attempts to operationalise ‘saturation’ as only being possible with a minimum of 12 datasets (233). This is based on a perspective that meaning is inherent in the data, rather than meaning being developed through interaction with the data and subsequent interpretation (231). As such, it is difficult to anticipate what sample size will be required prior to analysing the data, as it is not possible to know what the analysis will derive, until it is started (231). With determining a priori qualitative sample size therefore inherently problematic (234), the concept of information power has been proposed. This concept outlines how the more information held within a sample that is relevant to the research aims, the lower the number of participants that will be required (231,235). This has been considered as a useful alternative to ‘saturation’ as it is both pragmatic and allows for a purposeful decision to be made on required sample size, underpinned by ongoing analysis (231,234).

It was anticipated that due to the need to recruit participants with LBP (n=7), knee (n=7) and shoulder pain (n=7) each with different experiences regarding imaging within their care, that more patient participants would be required than clinicians. When utilising information power as a concept, an initial approximation of a sample size is required to inform planning however, the final sample size was continuously reviewed throughout the research process (235)

4.2 Data Collection

Participant characteristics were collected for both patients and physiotherapists as part of this investigation. The characteristics collected were agreed as a research team to ensure a diverse sample, relevant to achieving the research objectives. Through collecting these characteristics, a thick description of the study setting has been possible meaning that the transferability of the findings is enhanced. Transferability relates to the ability to applying findings from one context to another (236)

For patients these included:

- Sex
- Age
- Presenting complaint (i.e. LBP, knee, or shoulder pain).
- Clinical diagnosis
- Duration of symptoms prior to appointment with FCP/APP or Consultant Physiotherapist.
- Been referred for a scan **or** indicated an expectation for a scan **or** undergone a scan.
- Imaging modality if referred/undergone a scan

For clinicians these included:

- Age

- Years qualified
- Work setting
- FCP **or** APP **or** Consultant Physiotherapist
- Years in FCP **or** APP **or** Consultant role.

The interviews lasted approximately 40 to 60 minutes according to interviewee preference at a mutually convenient time. They were audio-recorded prior to being transcribed verbatim via an external agency (www.dictate2us.com). Dictate2Us Ltd as an organisation are compliant with GDPR regulations, the servers are 256-bit SSL secured and their team of transcribers are subject to non-disclosure agreements. When using a professional transcription service, there is potential that the opportunity to immerse in, and familiarise with the data is lost. However, given the transcripts would need to be checked for accuracy by reading in parallel to listening to the recording, it was felt this would continue to provide opportunity for both immersion and familiarisation.

The interviews were one to one, semi-structured based on two topic guides. The initial draft topic guides **(Appendix 25 and Appendix 26)** for the two stages within this study were developed by the lead researcher in consultation with the academic supervisory team. These topic guides evolved throughout data collection and updated accordingly **(Appendix 27 and Appendix 28).**

4.3 Data Analysis

Thematic analysis is an approach to qualitative data analysis where the data is coded and organised into themes that represent the data. Thematic analysis was chosen due to its inherent flexibility and theoretical freedom alongside the ability to provide rich and detailed understanding from the data (128). The 6-step method for thematic analysis outlined by Braun and Clarke (128) was used whereby the aim is to identify, analyse and report patterns within the data.

Analysis of the transcripts was led by AC and began with data familiarisation through a process of reading and re-reading (Step 1); during this process, the transcripts were independently coded (Step 2) using an iterative coding strategy and coding framework in a manner which facilitated data retrieval and comparative analysis (237). Once coded, the initial codes were organised into preliminary themes (Step 3) as the first step from descriptive (summarising what is in the data) to interpretative (making sense and finding meaning in the data) (238). A theme is a broad unit of information that is made up of several codes grouped together to form a common idea (129). These preliminary themes were then critically reviewed by the lead researcher and academic supervisory team, discussed, and refined (Step 4) to provide more meaning to the data through interpretation prior to the final themes being defined (Step 5). The final step involved outlining the results of the analysis. Once the results were outlined, they were shared with participants to verify the data and interpretations.

To enhance the rigour of this process, reflexive notes **(5.1.1, 6.11)** were kept throughout with these being shared with the supervisory team prior to being discussed in supervision (transferability, dependability, confirmability); peer-debriefing through supervisory meetings to test insight and aid interpretation **(6.1.1)**; with the final analysis shared with all participants **(5.1.1, 6.1.1)** to verify data and interpretation (confirmability, credibility) (236).

This chapter presented the background and methods underpinning the qualitative investigation. This qualitative investigation explores the reasons for requesting diagnostic imaging from the perspective of the referring clinician and patients.
In the next chapter, the results of the patient interviews, including the detail that underpins the analysis described above, and subsequent discussion are presented.

Chapter 5: Understanding the use of diagnostic imaging for MSK pain conditions affecting the lower back, knee, and shoulder: findings and discussion of a qualitative investigation of the patient perspective.

Summary

This chapter presents the findings and discussion of the patient interviews. This qualitative investigation explored the use of diagnostic imaging for non-traumatic, MSK pain conditions affecting the lower back, knee, and shoulder from the perspective of the person presenting with pain.

5.0 Findings

Ten patient participants were recruited, this was a purposeful decision based on ongoing analysis which meant that sufficient information power was obtained to address the aims of this qualitative investigation; three with knee pain; four with shoulder pain; and three with lower back pain. Seven of the participants were male (70%), age range was 38 to 75 years (mean 60.1 years). Six of the participants had undergone diagnostic imaging as part of their care (USS, MRI, or X-ray); three had expected imaging; and one had been referred for imaging but was awaiting this **(Table 10).**

Table 10: Description of the patient participants

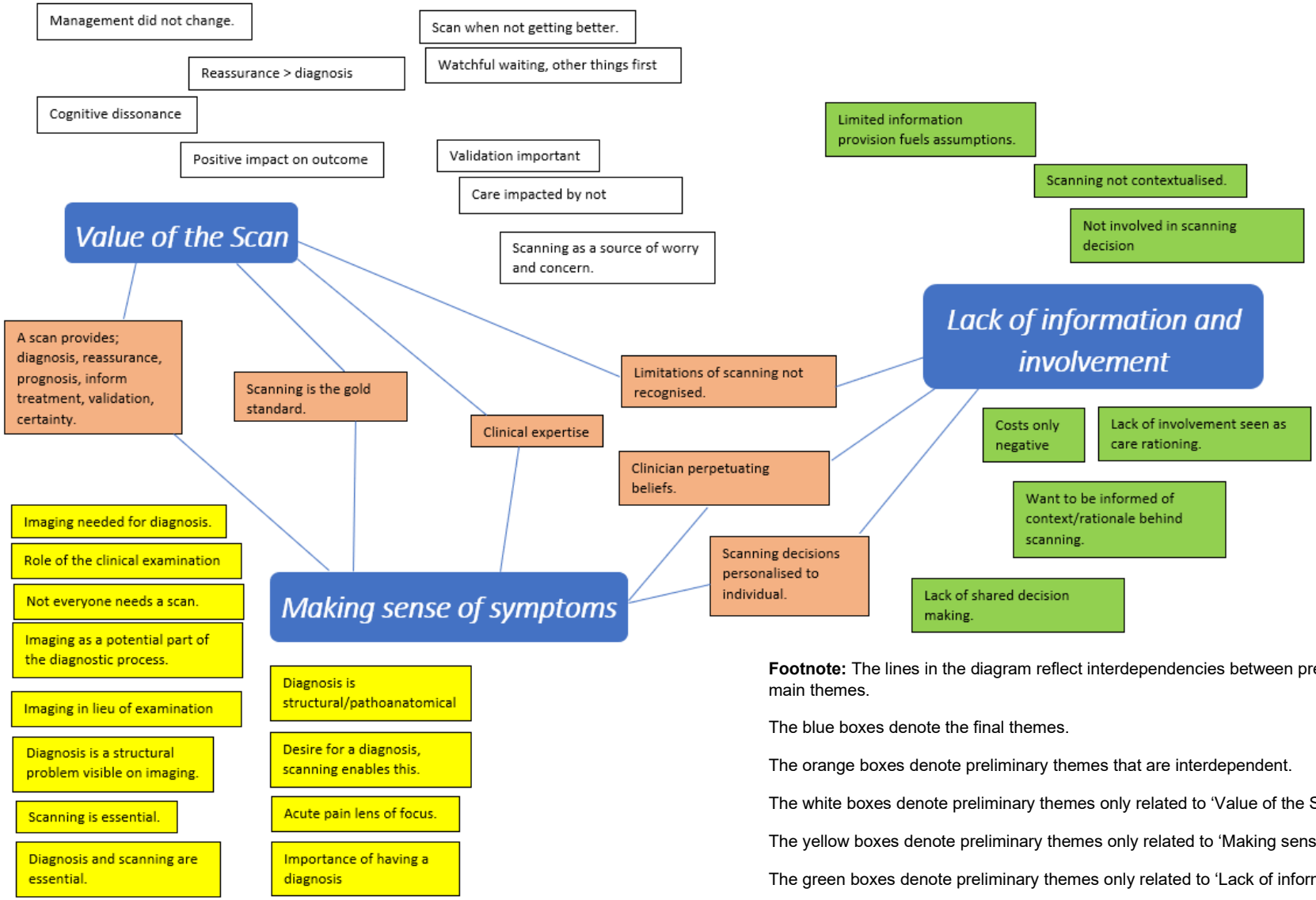
ID	Age (Years)	Body Site	Symptom Duration	Imaging Status	Imaging modality (if applicable) that the patient received
1	42	Knee	10 months	Referred for an MRI	MRI
2	75	Shoulder	12-months	Had a USS	USS
3	61	Knee	10-months	Expected an X-ray	Nil
4	65	Lower Back	2-years	Had an X-ray, expected an MRI	X-ray
5	59	Shoulder	6-years	Expected to undergo diagnostic imaging	Nil
6	38	Lower Back	18-months	Expected an MRI	Nil
7	75	Shoulder	"Years"	Had an X-ray and an USS	X-ray, USS
8	60	Shoulder	12-months	Had an X-ray and an USS	X-ray, USS
9	67	Lower Back	9-months	Had an MRI	MRI
10	59	Knee	8-months	Had an X-ray, USS, and MRI	X-ray, USS, MRI

Following familiarisation, initial codes were labelled by AC across all interview transcripts to identify text across the dataset that were relevant to the research aims. There were 100 initial codes, following the removal of duplicates. These initial codes were then reviewed and refined, resulting in 67 codes.

These 67 codes were then organised into preliminary themes with reference to the coded data **(Figure 6)**. This process was iterative, with preliminary themes being refined and interdependencies identified through discussion and challenge within regular supervisory meetings, prior to the main themes being identified.

Three main themes developed from the data: 1. Value of the scan, 2. Making sense of symptoms, 3. Lack of information and involvement. The themes have been presented below under these headings with anonymised quotes from participants used to support the narrative.

Figure 6: A pictorial description of the preliminary themes, final themes, and their interdependencies.



Footnote: The lines in the diagram reflect interdependencies between preliminary themes and main themes.

The blue boxes denote the final themes.

The orange boxes denote preliminary themes that are interdependent.

The white boxes denote preliminary themes only related to 'Value of the Scan'.

The yellow boxes denote preliminary themes only related to 'Making sense of symptoms.'

The green boxes denote preliminary themes only related to 'Lack of information and involvement'.

5.0.1 Value of the scan

This theme related to the value that patients placed upon having a scan as part of their care episode. This included both perceived value and actual value. There was an appreciation from patients that a scan was not always required.

> *"I think that sometimes it (having a scan) is not necessary. I think if I could have had done the exercises and it improved, you could carry on and tolerate and do everything really. Sometimes, oh, it's a bit worse than others but if you could just carry on with the exercises and a bit of pain relief sometimes, I don't think it's necessary to have lots of scans and x-rays and things like that."* – ***Participant 9, Lower Back Pain***

Instead, most participants indicated that the scan should be utilised when the persons' symptoms persist, and these symptoms impact the persons quality of life.

> *"Mainly, we can give some you know limited time, a short time, two-weeks, two-months, even three-months after then, if we can't get it better then obviously, the next stage should be without delaying any time, without delaying any further, we should send for a scan."* – ***Participant 1, Knee Pain***

Participants perceived the value of the scan to be wide ranging including to provide a diagnosis and to identify the required treatment.

I thought you know, the treatment will start obviously after, you know, finding out where the exact spot is. At that point, I start raising that I should go for an MRI scan, you know, at least we'll know what the actual problem with the leg is." – ***Participant 1, Knee Pain***

For others, it was to provide certainty about cause.

"*In her (physio) words, "I can't see inside your back, I'm indirectly guessing as to what the problem is and not the full extent of the problem…If I had to phone the private hospital, right, I would've gone and seen the doctor there, and he'd of x-rayed it, and the reason he'd of x-rayed it was to do his job properly"–* ***Participant 4, Lower Back Pain***

"To actually have it x rayed, so they don't have to lay a hand on you they can assess it just off the X ray itself on the scan, they know exactly what is wrong, exactly what is needed" – ***Participant 3, Knee Pain***

Another perceived value was the reassurance that it was not anything sinister.

"You start thinking the tumours don't you, and things like that… it's just human nature, you start thinking the worst. And all these things could be sorted out and eradicated by doing what they should do, and in my case

that was giving me an x-ray or a scan or both." – ***Participant 4, Lower Back Pain***

Or to help inform their understanding of their prognosis:

"they said that it always takes time, and it can take from like 12 month to 18 month and so, my next question was when I, you know, players for example, footballers and cricketers, they get injuries and they get fixed you know, very quickly, so why not, they never wait for 18-months or 12-months, so why can't you send me for a scan." – ***Participant 1, Knee Pain***

Whilst if symptoms persisted and a scan was not part of their care episode, it was considered that care provision may be sub-optimal.

"it's been very tough; I've always felt like I wasn't getting anywhere. It's taking so long. It was getting worse… but I suppose the end product for me was when I had the scans…I pushed the doctor on the phone for can you get me a scan and basically, they did a few months later." – ***Participant 6, Lower Back Pain***

Regardless of this wide-ranging perceived value, the actual value of the scan was less clear from the patient's perspective. The ability to recall what the scan showed was limited.

> *"Oh, medical terms! But erm, when he showed me on the screen it was like erm, how do I explain, it was like, your muscle deteriorated, you know, off you, you know off your bone. I'm not a medical man, so it was like, a thing of sausages if you understand that. One bit was okay, then there was a bit of a lapse, then it was about three or four different things that came up"* – ***Participant 2, Shoulder Pain***

Patients also reflected that their treatment did not change following their scan, with symptoms continuing to be impactful.

> *(Did the MRI scan change your treatment?) "Not really. I suppose, I mean, what do you mean when you say treatment? No, I wouldn't say so. I still do the exercises… I wasn't getting any better, but it was me who had to bring the scan up. It wasn't offered to me, it was me who kept pushing for it, and I may still to this day. 100% glad I had it done."* – ***Participant 6, Lower Back Pain***

Although the scan was considered authoritative from the patient perspective when compared to the clinical examination.

(Do you think a clinical assessment is sufficient to know what is going on?) "No, because it, using her (the physio) words, "We need to look inside your back to find out the extent of the damage and what has caused it or what is causing it," so in that respect, I needed an x-ray and I needed a scan." – ***Participant 4, Lower Back Pain***

However, participants did expect that the clinician should have the expertise to inform what may be happening without a scan and to inform when a scan should be considered, reflecting that not everyone needs a scan.

"I think you should be left down to the specialist who sees you. If he can feel and see enough evidence of what it is himself without sending you to another department for an x-ray or a scan, then he should be able to make that decision. I mean, he's paid a lot of money and he's very professional, so you'd hope that he'd have some insight without an x-ray… Yeah, yeah, we got to have a little faith in their professionalism as well, haven't we?" – ***Participant 5, Shoulder Pain***

5.0.2 Making sense of symptoms

This theme relates to how the person made sense of the symptoms that they were experiencing.

"It was complete disaster, I've tried everything that I was, you know, meant to do… but no joy, no difference. And also, it kept changing the position, for example, your clinic when I firstly raised the issue because my doctor referred to your clinic, the first thing I told them, I'm feeling pain on the outside of the knee…on the next call, I was saying no, it's on the inner side of the knee, so I was not able to identify the exact point." ***Participant 1, Knee Pain***

Participants all reflected on not seeking care immediately after symptom onset rather, when symptoms had persisted.

"I think I went at the end of March. I remember doing it at the beginning of March but I'm thinking it will just get better, it will just get better, but it didn't so I did ring them." - ***Participant 10, Knee Pain***

The initial watchful period seemed to be related to a tension between their experiences of pain or illness to date and the development of MSK pain which was often persistent and long-term in nature.

I think probably a lot of people who have back pain, don't they, it does get better, but when it doesn't then you just feel a little isolated and you're not quite sure of what to do." – ***Participant 9, Lower Back Pain***

Participants expressed a desire for a diagnosis, and an explanation of what was the cause of their symptoms. The desire to make sense of their symptoms developed further when an incompleteness of physical examination and lack of patient understanding about diagnosis stimulated their thoughts about needing a scan.

> *"I thought that he would send me up to the hospital and they'd either scan or x-ray it. Because I wasn't allowed to get it checked out properly, I wasn't exactly certain (do you mean assessed face-to-face?). Well, assessed face to face would have better, but I'm talking about scan or x-ray, that way they can see for themselves."* ***Participant 3, Knee Pain***

This was considered from the patient's perspective that a diagnosis was pathoanatomical, a structural fault that could be identified.

> *"I thought they might have a look at some X-rays or something to find out what the problem was, rather than just, I don't know, maybe assume."*
>
> ***Participant 8, Shoulder Pain***

From the patient's perspective, a combination of factors was used by the physiotherapist to determine the diagnosis; the role of scanning in providing insight, the clinical examination and the expertise of the clinician were considered.

"She (private physiotherapist) was a top physio she's worked for Great Britain at the Olympics and what have you so she knew what she was talking about…says "you've got damage to the base of your spine and in my opinion, it's either disc three, or disc four". She says, "obviously, I can't …", these were her words, "I can't see inside of your back we need an X-ray doing to see the extent of the damage and what basically has caused it, but you need an X-ray and a scan, go and see your GP." – ***Participant 4, Lower Back Pain***

"Physiotherapist said, without actually being able to see into it, he suspected that it may be some impingement or arthritis setting in." – ***Participant 5, Shoulder Pain***

Most participants outlined that the prospect of undergoing imaging as part of their care was introduced by the clinician, rather than by the patient themselves.

"It was suggested to me (to have a scan), but I was glad that it was because I did want some tests doing. I mean I - I suppose - I suppose I'd been a bit frustrated previously that no tests have been done. You know, it was - it was just - It's not "guesswork". ***Participant 8, Shoulder Pain***

"I spoke to him on the telephone, he went through a lot of things and then he said he would refer me for an MRI, which he did". – ***Participant 9, Lower Back Pain***

"The specialist sent me straight through for a scan. I went straight back to him 15, 20 minutes later and he said that he was going to give me the injection there and then and see how it goes". – ***Participant 5, Shoulder Pain***

For the majority, it was felt that clinicians had difficulty in providing a diagnosis in a way that helped them make sense of their symptoms, without the use of imaging.

I thought I might have had an MRI rather than a plain x-ray. And he said no, you just need an x-ray. Fine he's the professional, he is in the know. The only thing I did find a little odd and we can't help it was that he didn't see my knee. He didn't physically see it or examine it." – ***Participant 10, Knee Pain***

5.0.3 Lack of information and involvement

This theme relates to patient perceptions of how diagnostic imaging was used within their care episode. Participants were consistent in that they did not feel involved with the decision whether to scan or not.

(Were you involved in the discussion about sending for an investigation) "Not totally, no. It was - I was always asked if I was happy with that, but maybe never really consulted and been the kind of - the character I am, I just say, "Yes, that's fine." - ***Participant 8, Shoulder Pain***

Specifically, they did not perceive that the role, purpose, benefits, or limitations of scans were discussed but were clear that such information would be welcomed.

"(Were you provided with any information as to why you weren't being referred for an x-ray?) No. No. To be quite honest with you, I started to question the system and you listen to different people's experience of going to the doctor's, or going up to the hospital, and this, that and the other. Some have got x rays, and some haven't been given X rays. And then you start questioning well, why am I not being given an X ray?" – ***Participant 4, Lower Back Pain***

"No, not really. I think I got letter from the hospital basically saying what's been wrong with me but, no, as far as I know, just had an MRI scan to check what was wrong, I wasn't really given any clear information." – ***Participant 6, Lower Back Pain***

In the absence of this information being discussed, the majority of patients reflected that if a scan was not organised then this was perceived to be due to barriers such as cost or rationing of care.

> *"Which for whatever reason, they didn't want to do. And there's no two ways about it, they didn't want to do it. And the only reason I can see, the reason they don't want to do it is because of money".* – ***Participant 4, Lower Back Pain***

Or system recovery from COVID, rather than there being clinical rationale for not ordering a scan.

> *"(Why do you think your GP didn't organise an X ray or a scan this time around?) I think it was because the NHS was being so overwhelmed (with COVID) that they didn't have time or placement to put anybody in."* – ***Participant 3, Knee Pain***

With reference to all the perceived potential benefits of having a scan (e.g., rule out sinister pathology, guide treatment) highlighted so far, there were limitations, including cost, safety, iatrogenesis that participants did not appear to consider. Participants expressed only a limited appreciation of potential limitations of diagnostic imaging, namely cost.

"No, there can't be any negatives to it. Because once the doctor can read what the actual scan or the X ray is he knows what to do. Whereas, if he doesn't scan or x-ray it then it is just a judgement call." - ***Participant 3, Knee Pain***

"Obviously, the cost is involved. I don't know the background of it, whether you guys are able to send everybody to the scan or not… a friend was mentioning, just quoting him, mentioning that 'they are not going to send you for a scan'. The general public thinks that their budget doesn't allow it, they will send you to the physio, and that their budget depends, if it is not allowed, they will take you to the next financial year and this and that." **– *Participant 1, Knee Pain***

One participant, with a professional background in nuclear radiation, considered the safety considerations associated with the use of imaging.

"Well, the amount of radiation from an x-ray to your shoulder, I believe, and I've been… well, I've asked the question obviously what, just how dangerous it is and it's, you know, very, very minimal. So, an x-ray, one or two x-rays shouldn't really be of any concern I wouldn't think. So, in my personal situation, I disregard that risk really. (Was the risk of radiation

discussed with you pre X-ray?) No. I've worked in nuclear so I am aware of what's going on around so it's – I think for anybody who doesn't know anything about radiation, and it would be quite beneficial to know." - ***Participant 7, Shoulder Pain***

Aligned to this, the majority of participants were clear that they wanted to be involved in the decision to scan or not to scan.

(Were you involved in the discussion about sending for an investigation) "Not totally, no… (Would a shared decision have been of use?) I think I - yeah, I think I would have liked that."- ***Participant 8, Shoulder Pain***

Additionally, wanting information around the role, context, risks, benefits, and purpose of the scan within their wider treatment plan tailored to them as an individual.

"I understand where it's all been said about wear and tear and that at that age, that should be sort of, you know, so and so and whatever. But, you know, sometimes everyone is different, isn't it, you know, younger people have things that are wrong when you think, gosh, you're only young, you should be sort of fit and well and healthy… I don't think it would have made any difference to me." – ***Participant 9, Lower Back Pain***

5.1 Discussion

The purpose of this qualitative study was to fulfil objective **iii** (**see 1.4)** of this thesis; to understand why diagnostic imaging is requested, and how the imaging findings are used from the perspective of patients with lower back, knee, or shoulder pain. This qualitative study has identified the factors underpinning the role of diagnostic imaging and in doing so provides new insight into the patient perspective. From the patient perspective, three themes were identified; (1) *Value of the scan;* (2) *Making sense of symptoms;* (3) *Lack of information and involvement.*

Whilst the value of the scan from a patient perspective was considered wide ranging, this appeared to be more related to a perceived value than an actual value. The ability to recall what the scan showed was limited, and the management of the patient did not change following imaging. It is possible therefore that the value of the scan perceived following diagnostic imaging represents a post-truth, a situation whereby people explain an attitude or opinion based on their beliefs and emotions, as opposed to facts (239). As such, it may be that the actual value of imaging is the validation of the impactful symptoms that the person is experiencing. The process of referring for diagnostic imaging resulting in an interpersonal recognition that the impact of the symptoms has been understood and action taken to try and alleviate this impact, resulting in both satisfaction and positive affect, even if management does not subsequently change (240,241).

The influential nature of diagnostic imaging to inform patient understanding of their symptoms has been reported in the literature in studies that have looked at the patient experience of diagnosis and treatment for MSK pain conditions, including knee pain (222,225) and shoulder pain (223). This subsequently leads to patients understanding their symptoms from a pathoanatomical perspective and was further highlighted within this study. What this study adds however is the insight from the patient perspective that whilst diagnostic imaging is considered authoritative, there is an expectation that clinicians should have the expertise to inform understanding following clinical examination. Patients started to consider the need for diagnostic imaging when either clinical examination was felt to be incomplete, or the patient did not fully understand their symptoms and why they were occurring. The clinical implications of this insight highlight the need to consider methods of both reassurance and education alongside the capability to communicate effectively **(Chapter 7)**, within the clinical encounter.

The importance of effective communication is further highlighted through patients expressing a desire to be involved in the decision-making process regarding the use of diagnostic imaging. This perceived lack of involvement resulted in patients perceiving that they were not fully aware of the benefits, risks, and purpose of diagnostic imaging as well as enabling the development of faulty beliefs such as care rationing. There are clear clinical implications here supporting the use of shared decision making between clinician and patient to enable the development of an agreed and collaborative management plan. The use of shared decision making within physiotherapy practice, including referral for imaging, has been suggested as an integral component of high-

quality, evidence-informed personalised care (114). The findings from this study would further support this suggestion **(Chapter 7)**. Whilst embedding shared decision making within clinical practice has been acknowledged as a challenge, with barriers such as time and expertise being cited as barriers, the potential of shared decision making to optimise use of finite healthcare resources has also been recognised (242). Future research should explore the effectiveness of implementing and encouraging the use of shared decision making as an intervention to facilitate appropriate use of diagnostic imaging **(Chapter 7)**.

With finite healthcare resources, there has been focused attention over the last two decades amongst wide-ranging stakeholders on the overuse of imaging, with a focus on trying to optimise use to those circumstances where there is clinical need and a value add to patient outcome (243). These stakeholders include policy makers, health ministers, and clinicians however, there appears to be an apparent tension given the perceived value of the scan from the patient perspective. This is particularly relevant when patients considered their care to be sub-optimal if their symptoms persisted and diagnostic imaging was not utilised. This appears to stem from patients considering their symptoms from their experience of acute health episodes. Namely, symptoms start, are diagnosed, and resolve in time with or without treatment. Given the epidemiology of MSK pain conditions suggesting both an increasing prevalence (2,23,244), and a tendency to be long term conditions (115,245), there is an apparent public health need to educate and inform around their nature **(Chapter 7)**. In turn this will help to facilitate

appropriate expectations in terms of both the care they should receive, as well as longer term prognosis and management.

5.1.1 Strengths and Limitations

The breadth of the sample in terms of body site, interaction with imaging (i.e., had a scan, expected a scan, or awaiting a scan), and sex should be considered a strength following purposive sampling. Further enhancing transferability, as well as confirmability (the extent to which the findings reflect the focus of the study) and dependability (the extent to which the study could be repeated, and any variation seen in the findings understood) of the findings, reflexive notes were kept throughout the research process (236). These reflections were critically discussed in supervision meetings alongside the recordings of the interviews. This was to ensure that the interpretations and conclusions were representative of the data, and not over influenced by my bias as the researcher.

An example of this reflexive activity relates to considerations around interview duration and my total speech amount relative to the participants. The patient interviews were typically shorter than the clinician interviews, and in early interviews, I was speaking more than the patient. Reasons for this were discussed such as was I probing answers enough; using too direct as opposed to open questions; or lacking confidence as an interviewer. In turn, this became an area to actively focus on in subsequent interviews, ensuring I used appropriate prompts and probes, as well as adopting a more open questioning style. As interviews progressed, they became longer in duration and I spoke

less however, I still would speak to a greater extent than in the clinician interviews. My reason for this was to ensure that the question asked was structured in a way that made sense to the participant, within the context of the research objectives. This has the potential to imply a certain direction, or influence a participant's response and as such, I would consider and reflect on question wording to keep the context neutral. Through the responses from participants during the member checking process, I am confident these measures were successful given the analysis was corroborated as accurate and reflective of the interviews, providing further support to confirmability and credibility of the findings.

5.1.2 Conclusions from the patient interviews

The value of undergoing diagnostic imaging was considered wide-ranging from a patient perspective in attempt to help make sense of their symptoms, with this value appearing more perceived than actual. Despite this, patients did not feel fully informed or involved in the decision-making process.

This chapter presented the findings of the patient interviews and how from a patient perspective, the value of undergoing diagnostic imaging is wide-ranging however, patients do not feel fully informed around the decision to scan or not. In the next chapter, the findings of the clinician interviews will be presented. This represents the findings of the qualitative investigation exploring the use of diagnostic imaging for non-

traumatic, MSK pain conditions affecting the lower back, knee, and shoulder from the perspective of the referring clinician.

Chapter 6: Understanding the use of diagnostic imaging for MSK pain conditions affecting the lower back, knee, and shoulder: findings and discussion of a qualitative investigation of the clinician perspective.

Summary

This chapter presents the findings of the clinician interviews. This qualitative investigation explored the use of diagnostic imaging for non-traumatic, MSK pain conditions affecting the lower back, knee, and shoulder from the perspective of the referring clinician.

6.0 Findings

Ten clinician participants were recruited, all Physiotherapists. This was a purposeful decision based on ongoing analysis which meant that sufficient information power was obtained to address the aims of this qualitative investigation; one was a Consultant Physiotherapist within an intermediate MSK service; five were Advanced Practitioners (APP) within an intermediate care MSK service; and four had a split role combining being an APP in an intermediate care MSK service with being a First Contact Practitioner (FCP) in primary care. All Physiotherapists within this sample would request imaging from a radiology provider, none would perform imaging themselves i.e., point-of-care ultrasonography. Seven of the participants were male (70%), age range was 32 - 52 years (mean 39.4 years) **(Table 11).**

Table 11: Description of the clinician participants

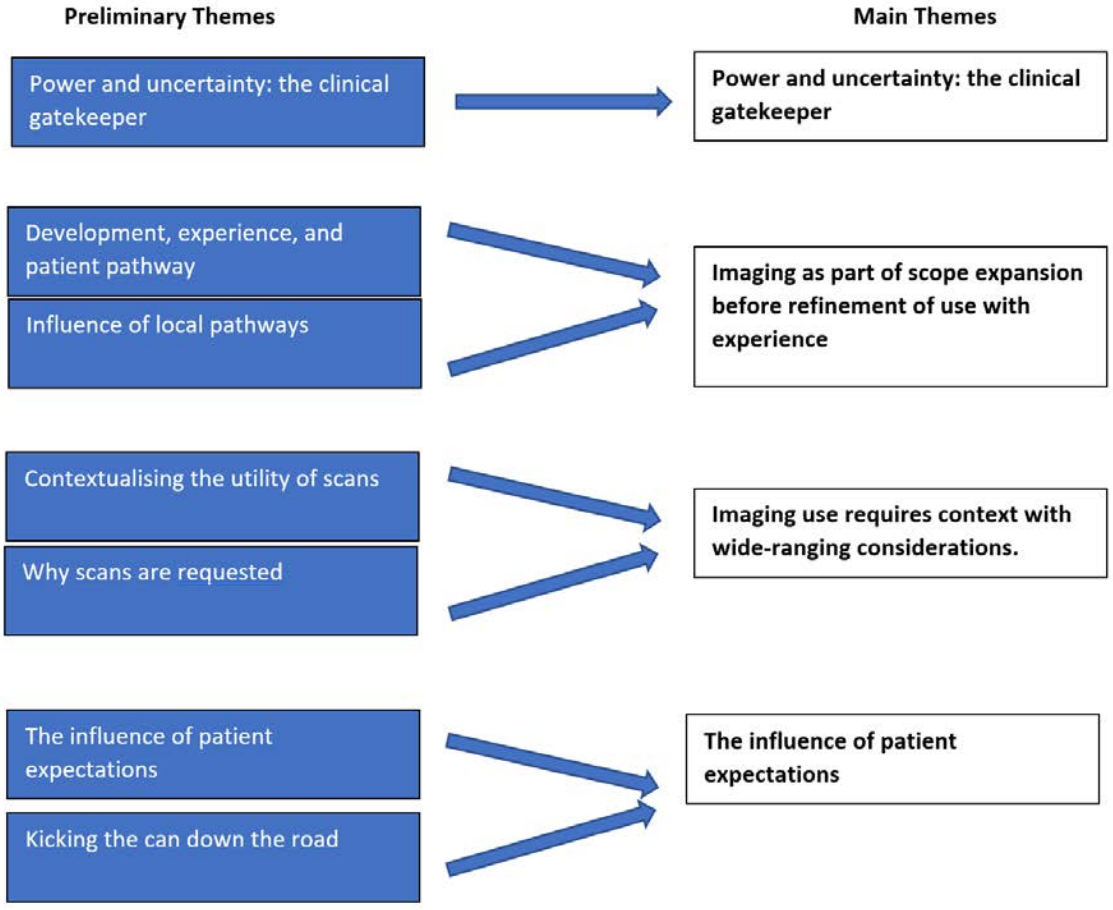
ID	Age	Years Qualified	Clinical Setting	Level of practice (role)	Years in role
1	41	19 years and 6 months	Intermediate Care	Consultant	4 years and six months
2	36	12 years and 3 months	Intermediate Care	APP	5 years and 5 months
3	40	17 years and 9 months	Intermediate Care	APP	6 years and 6 months
4	32	6 years and 2 months	Intermediate Care	APP	1 year and 2 months
5	35	12 years and 10 months	Intermediate Care	APP	1 year and 4 months
6	34	13 years	Intermediate/Primary Care	APP/FCP	4 years APP; 9 months FCP
7	36	13 years and 11 months	Intermediate Care	APP	3 years and 3 months
8	45	22 years	Intermediate/Primary Care	APP/FCP	5 years APP; 1-month FCP
9	52	30 years and 6 months	Intermediate/Primary Care	APP/FCP	20 years APP; 6 months FCP
10	43	21 years and 6 months	Intermediate/Primary Care	APP/FCP	3 years APP; 3-months FCP

Following familiarisation with the data, initial codes were inductively labelled across all interview transcripts by AC. There were 391 initial codes, following the removal of duplicates.

These initial codes were then reviewed and refined, resulting in eight preliminary themes. This process was iterative, with preliminary themes were refined prior to the development of the main themes **(Figure 7)**.

Four themes and were developed from the data: 1. Power and uncertainty: the clinical gatekeeper, 2. Imaging as part of scope expansion before refinement of use with experience, 3. Imaging use requires context with wide-ranging considerations, 4. The influence of patient expectations. The themes have been presented below under these headings with anonymised quotes from participants used to complement the narrative.

Figure 7: Themes identified from interviews with referring clinicians regarding the use of diagnostic imaging for non-traumatic, MSK pain conditions affecting the lower back, knee, and shoulder.



6.0.1 Power and uncertainty: the clinical gatekeeper

Power, in the context of this data, related to the ability of the physiotherapist to influence the course of events by acting in a particular way. To refer for imaging, the clinician needed to decide that this was the chosen course of action, and to then request the imaging to be performed by a radiology provider. Within this decision-making process, the amount of risk that was inherent with diagnostic uncertainty, and the clinical presentation were considered however, there was variation in the amount of risk an individual clinician was willing to accept, and how they in turn tolerated the ensuing uncertainty. This influenced subsequent referral for imaging by clinicians.

> *"If my gut instinct was that this doesn't quite fit that normal pattern, it doesn't quite fit what I would expect this problem to be presenting like then, yeah, I might image it in that situation, certainly for some diagnostic clarity"* – ***Clinician 6***

> *I suppose it's more for those cases where you're 99% certain, again, coming back to gut feeling conversation that we had, where things don't quite, they're not quite adding up"* – ***Clinician 1***

The clinician as a gatekeeper, and their reasoning of the clinical presentation then became evident as a barrier to shared decision making. If the patient was uncertain as to cause, or worried about their symptoms, and felt a scan was required, as reported in

the previous qualitative investigation in chapter five, but the clinician felt comfortable, then the power dynamic became apparent.

> *"I've gone through this sort of year and a bit of being this like, gatekeeper of imaging, like this tyrant of nobody allowed an MRI scan, unless you really, really, really warrant it"* – ***Clinician 2***

> *"If I'm happy with a presentation, and I'm confident in my diagnosis, and a patient wants an image, I'm not going to order an image, if I'm confident"* - ***Clinician 1***

In this instance the downstream effects, such as potential worry, iatrogenesis, likelihood to undergo invasive treatment, were cited as a reason to not scan.

> *"We know reassurograms can be not reassuring for a lot of patients…If someone's not adequately prepped to inform them about imaging findings and they read that, it might create a worsening, perceive their problem to be worse than it is, like I mentioned before"* – ***Clinician 5***

> *"When it came to people coming in, wanting to have investigations done and I'd be like no, no… you don't need to investigate things, imaging is iatrogenic, it can cause nocebic harm* – ***Clinician 2***

Despite the concerns around downstream effects, it was recognised that for some patients, a scan may be the only way to get 'buy in' to their proposed management plan.

> *"You see people who loop around in the system and they're difficult to, to manage without doing the imaging… if I'm imaging in that situation, it's not because I clinically think it's needed. It's because I'm under pressure."* – ***Clinician 4***

However, if a clinician was not sufficiently certain regarding a patient's symptoms or providing a diagnosis, then the clinician may scan to reassure themselves, aligning with a risk-based approach to requesting imaging.

> *"…sometimes I'll order reassurance for me and that's if I think that, well if they've got this history of like some sort of sinister pathology, or if they've got something that doesn't feel right, that's reassurance for me. And I'm much more likely to order imaging in that case, if it's reassurance for the patient we'll go through the rigmarole because I'm sort of 80 to 90% confident it's just going to be a normal scan, if it is reassurance for the patient, I'll try and have that difficult conversation"* – ***Clinician 4***

> *"Language barriers as well, if you don't really understand someone, you…use a diagnostic just to make sure that you've not missed something"* – ***Clinician 3***

This was particularly evident within the context of not missing a serious diagnosis. If uncertainty existed, it was felt by clinicians that scanning was authoritative, this was stronger in those with previous experience or complaints related to such matters.

"Despite not knowing anybody who has been subject to any kind of litigation or negligence… It's always a challenge. It's not something that significantly drives my practice but it's always something I'm conscious of to larger or smaller degrees" – ***Clinician 6***

"I think it probably just gives me a little bit of a reassurance that there's nothing…I'm not expecting to be there" – ***Clinician 10***

"So I think, if you scan someone and they have an incidental finding and you think ooh that wasn't even on my radar. But now I've got to then escalate them a Consultant. So I think that that probably then makes you image a bit more than what you might have imaged in the past not because you think there might be cauda equina despite no symptoms, but it's the 'what else could be in there that I might be missing?'. So I think that's it's the fear of missing something" – ***Clinician 2***

There was an appreciation that other mechanisms may exist to provide greater certainty or assurance rather than relying on scanning, such as discussing within the MDT, sharing the uncertainty felt with the patient, or through peer support.

> *"I would probably surmise that more investigations are done because people have got into that sort of anxiety state really about missing things or things have potentially been missed"* – ***Clinician 9***

> *"On the whole, it's anecdotal, but I think patients are generally reassured by good history, good examination, and good explanation… I think the key thing is managing that uncertainty, including the patient in your reasoning…more open about my reasoning, sharing some of that uncertainty"* – ***Clinician 6***

6.0.2 Imaging as part of scope expansion before refinement of use with experience

The majority of clinicians outlined how they had expanded their scope of practice to include the ability to request imaging in order to enable career development into an APP role.

> *"So, it was part of sort of career progression. So, I was a physio doing lots of rehab, advice, exercise. I was quite a senior physio; I'm qualified six*

years now. And then I just wanted to expand my scope of practice to, to see, to help patients in different ways when they failed rehab, or not improved significantly with rehab, so they had other treatment options" – ***Clinician 4***

Despite seemingly being a requisite for career development, whether requesting imaging was an essential part of an APPs clinical practice was questioned by the clinicians.

"…. a change in job role to become an Advanced Practitioner (AP), where all of that comes hand in hand because it is an intermediate care service (if you could have been an AP without having imaging requesting as part of your role, would you have been interested?) Back then probably not, but now yeah, I think it's a nice to have" – ***Clinician 2***

One participant, the most experienced as an APP, recalled that when they started requesting imaging, it was not a core part of their role.

"So I found myself at the beginning not with everybody but there were certain patients where you kind of think investigation may well be kind of an appropriate way to go but I always had to then go and ask the GP's permission or get them to do the referral." – ***Clinician 9***

Participants felt that imaging as a requisite for an APP role was driven by the pursuit of care pathway efficiency, with imaging occurring earlier on in the pathway (i.e., in primary/ intermediate care rather than in secondary care) and by a physiotherapist (rather than by a doctor) seen as more cost-effective, with the potential to optimise secondary care referrals, even if the management plan in turn does not change.

> *"If I'm referring somebody possibly to explore having a knee replacement surgery, then it would be expected of me that I would send them for an x-ray of that knee before sending a referral. Even though clinically, I know the person has osteoarthritis and ultimately that x-ray isn't going to change the management but it's something that I need to do, to do a full workup before sending that referral."* – ***Clinician 7***

The influence of experience in requesting imaging contributed to pathway efficiencies. The majority of clinicians reflected that early on after expanding their scope of practice, they would request a lot of scans before reducing over time as they became more aware of the usefulness and limitations of imaging.

> *"I think my use of imaging massively has, in terms of when I was in a baby AP I massively over imaged, it's like a new toy and you also have a little bit of professional fear that you don't want to miss something being in a new job role, so I definitely over imaged"* – ***Clinician 3***

"Yeah, so perhaps early days I would've been more likely to request imaging due to a lack of experience, or perhaps having less confidence in the diagnosis or being more open to being sort of steered that way by patients' wants rather than basing it purely on clinical need" – ***Clinician 7***

6.0.3 Imaging use requires context with wide-ranging considerations

When requesting a scan, clinicians aimed to ensure the context of the imaging request was understood by the patient. This was done mostly verbally, informing the patient of what they were looking for, how asymptomatic findings are common, and the limitations of imaging.

"I also would probably say that, you know, when we get your scan results back, there'll be lots and lots of information on there, lots of technical words, lots of jargon and we'll go through it together but typically, what we'd expect to see in a back of your age would be degenerative changes, it's just age-related changes, they're normal findings. It's a bit like grey hair, wrinkle. You know, sort of trying to sort of normalise some of the other stuff, so kind of setting the expectation around there will be stuff that we will see but it won't be necessarily relevant to your symptoms. There might be incidental things that we see, again, we need to put those in context" – ***Clinician 7***

It was felt that generally patients can recall this information following their scan and that it was well received at the time.

> *"It seems I've never had any kind of significant pushback or kind of conflict having said that. I mean, it's been an evolution, my practice, so, I can't remember any kind of specific examples where it's gone wrong. Patients often do remember discussing that there would be some changes" –* ***Clinician 6***

Whilst done verbally, there was a perception amongst participants that providing either written information or a video-based resource would be a better method for contextualising, facilitating a more active approach with patient involvement.

> *"It's mostly verbal, but sometimes if I'm sending them any information, I might send them something on say PhysiTrack. So, I might just send them a bit more information about say imaging and what kind of things might show up just so they've got some context for it" –* ***Clinician 7***

> *"…sometimes shoving numbers in front of patients, I don't think it gets internalised that well, erm I guess, I don't know what the best way is to educate them, on sort of normal findings. I try and send in videos and YouTube links" –* ***Clinician 4***

Whether the care setting in which the clinicians saw patients influenced their use of imaging, was inconsistent. If working as an FCP in primary care or an APP in intermediate care, this may have influenced use, dependent on caseload, but many also reflected no change in use.

> *"I think I would probably like to think that, from a personal point of view in the appropriateness of imaging, it will be no different where I would sit in. In that if a patient had a potential clinical need for it whether I was sitting in the GP surgery or as I previously was in the MSK service…that I would consider it was an appropriate option"* – ***Clinician 9***

What seemed to be more important was where you interacted with the patient on their journey i.e., early on after symptom development, or later where other options and time had not been successful.

> *"From a non-traumatic perspective, I don't think it changed whatever setting I was in. If someone had features that were in keeping with osteoarthritis and we're considering a knee replacement and had gone through the appropriate stages, whether I was seeing them in FCP or intermediate care, then I would organise the appropriate investigation and move them to the step"* – ***Clinician 2***

There were a variety of circumstances where clinicians felt that the utility of imaging would add value to patient care, influenced by multiple factors, dependent on the context of the consultation. In the main, imaging would be requested if it was safe, and there was a clear clinical question with the results expected to change management.

> *"I think my criteria is always 'is it going to change my management', plain and simple, and again like I said earlier in the conversation, really, I'm looking for, both the patient and I are in agreement, we are looking for a surgical or injection target"* – ***Clinician 1***

It was reflected that 'changing management' was open to interpretation, and the extent to which imaging results changed management in practice was variable, despite agreement that this was an important consideration.

> *"There are things like, the guidelines that are a bit more woolly… in terms of will it change your management? It's a bit of a, bit of a non-committal statement because you could argue that every time you image it will change your management because it will say that there is no, no opportunity for surgery here, there is no point sending you to an Orthopaedic surgeon, so that imaging will change the management but I always think that's been taught as 'will it change your management to lead*

to surgery', or that's how that statement has always been interpreted." – ***Clinician 2***

"Erm, I don't think it changes my management a lot, especially in the current service that I work in. Because say if they haven't improved, I wouldn't want to deny them a secondary care opinion. So I probably refer them anyway, it's just that the imaging is required to get there" – ***Clinician 4***

Other factors considered alongside changing management included the duration of symptoms, functional impact, and not responding to appropriate first line management.

"I guess with that if they explored all typical conservative treatments and they're not better when I would expect them to be or there's something that I think might be amenable to surgery" – ***Clinician 10***

Related to these considerations was the concept of looking for a surgical or injection target, where an appropriate injection or surgical option existed, with an appreciation that this is not always straightforward given the presence of asymptomatic findings.

"I would say that it is pretty rare to find a true surgical target, often it, it's difficult isn't it, because stuff like OA knee and stuff like that, there's

always OA knee after about 40 years of age, so we see loads of patients with early-to-moderate OA, is that a surgical target? Is it not a surgical target?" – ***Clinician 1***

Further, patients would need to be willing to undergo the intended invasive procedure for the scan to be requested. A patient could present with the same symptoms, presentation, diagnosis, and impact however, if they did not wish to undergo surgery or receive an injection, then a scan would not be requested.

"If it's going to help to move the conversation forward, and the patient is willing to then undergo the repercussions of that. So, if a patient wanted an image but wouldn't be prepared to have surgery or an injection, then again, I wouldn't order it because what's the point it's not going to change our management" – ***Clinician 1***

Other contexts where imaging was felt to have utility included a suspicion of specific pathology, red flag presentations, and pathway considerations. For example, scanning to exclude an amenable structural cause before referring into a persistent pain pathway.

"If I'm thinking about referring them to pain management then as part of that process, imaging might be indicated just to absolutely exclude anything that could be treated in a different way. And that's often looked

for by the pain management team in secondary care. They often want that workup to have been done fully before referring on just to make absolutely sure that there isn't anything specific that can be done" – ***Clinician 7***

If uncertainty existed, it was felt by clinicians that scanning was authoritative. There was consistency regarding the use of scanning when uncertain due to fear of missing something or litigation, this was stronger in those with previous experience or complaints related to such matters.

"Despite not knowing anybody who has been subject to any kind of litigation or negligence… It's always a challenge. It's not something that significantly drives my practice but it's always something I'm conscious of to larger or smaller degrees" – ***Clinician 6***

"I think it probably just gives me a little bit of a reassurance that there's nothing…I'm not expecting to be there" – ***Clinician 10***

"So I think, if you scan someone and they have an incidental finding, and you think ooh that wasn't even on my radar. But now I've got to then escalate them a Consultant. So I think that that probably then makes you image a bit more than what you might have imaged in the past not because you think there might be cauda equina despite no symptoms, but

it's the 'what else could be in there that I might be missing?'. So I think that's it's the fear of missing something" – ***Clinician 2***

Whether indications for scanning changed with spinal or peripheral presentations, a small majority of clinicians felt that the reasons for requesting in spinal presentations was different. These differences included the modality used (MRI more in spinal presentations, X-ray in the periphery); if an injection was being considered as a treatment option, with this procedure containing more risk than a peripheral injection, imaging prior to intervention was felt necessary whereas this was not the case for peripheral injections.

"… the modality I suppose I don't very often refer for spinal x-ray but with MRI so I suppose health wise, there's usually more contraindications to sending someone for an MRI as there would be for if you are referring for an x-ray" – ***Clinician 5***

"I honestly don't think that someone needs to have an X-ray, as an absolute before having an injection in the shoulder…I certainly don't do it in the knee. From a spinal injection, it has to be done" – ***Clinician 2***

Clinicians perceived that it was more straightforward to correlate imaging findings and symptoms to enable invasive treatment options that exist for those with spinal presentations and therefore, a scan is more likely to lead to a change in management.

"I guess with the spinal problems, if they've got more acute presentation, then they might be potential candidate for say an epidural…you are looking for that kind of direct correlation with findings on MRI…I think that is harder in the periphery. I think generally speaking for peripheral joints, you're less likely to be organising imaging early on" – ***Clinician 7***

6.0.4 The influence of patient expectations

If patients expected a scan, it was perceived by the majority of clinicians as a challenging conversation, especially if they felt that clinically a scan was not required.

"These conversations are really challenging, because you have patients that come in that don't even let you introduce yourself or say your name, just say I'm here to get an MRI or an MRI" – ***Clinician 3***

When a patient expected to have a scan, this influenced the clinical decision-making process.

"I think it probably does influence my decision making a bit in terms of the likelihood of them getting imaging is probably higher" – ***Clinician 7***

These expectations were perceived to be informed by a variety of factors. These factors included previous healthcare experiences of the patient; the opinions of friends and family; social media messaging; duration of symptoms; first line treatment not resolving

symptoms; and information provided by the referrer. The latter being perceived as the strongest influence.

> *"Dr. Google, the Nemesis…GPs are not MSK experts. Absolutely fair enough, they're amazing in what they do, but they can, GPs can sometimes be quite diagnostic, heavy, or say this is what you need. And still, in today's society, if a doctor says something, there's that element of 'Well, that's what I need, because the doctors said it'. So. I also think expectations of what friends and family have had, as part of their treatment, my friend had this and it solved their symptoms"* – ***Clinician 3***

> *"I think it's probably driven from a number of different areas really. I think some of it, to be blunt, is probably driven from the referrer. Yeah, some of it was based I think purely from the referrer just, you know, cynically it may well be, "So we'll send you to MSK, they'll MRI you," to get them out the room and avoid the difficult conversations"* – ***Clinician 9***

The relationship between patient expectations and wider societal beliefs were discussed by the clinicians, particularly in the context of a patient expecting a scan as part of their care.

> *"Patient demand. I think there's a sort of an unhelpful, or there has been over the last few years a focus on the sort of, I don't know, the benefits or*

the sort of, I don't know, the kind of perceived magic of the MRI imaging in particular, and I think people think that they have a scan and you can see everything and somehow sort of diagnose everything that's going on in their body." – ***Clinician 7***

Imaging was considered as a small contributory part of clinical reasoning, and it was felt that the majority of patients were accepting of this. As such, if the patient expected imaging, this would be explored with the patient to understand why they expect it and what they hoped it would achieve. A consistent strategy across clinicians was to agree a 'contract' with patients regarding first line treatment and expected timescales.

"(How much of your clinician reasoning is influenced by scans?) Probably 20% maybe, maybe even less. It's mainly to confirm something that I think is already a known thing. And, like I said, just to sort of kind of rubber stamp, a referral on, rather than anything else generally." – ***Clinician 7***

"So this is where I have this the conversation MRI scan doesn't show pain, what the normal anomalies are within an MRI and that it will not affect their future treatment. And actually, if there's been a gap in their treatment where they've not had the right level of physio or the right loading programme or whatever, you can say this is the plan we're going to go

away and do this for three months if it is not better in that time period, come back and see me we can discuss it, about MRI scans" – ***Clinician 3***

Despite societal beliefs being considered to influence patient expectations, it was apparent that the clinicians felt that health professionals have the ability and capability to influence such beliefs on an individual patient basis.

"I think the society expectations can be overcome with the expert health care professional. But as soon as another health care professional reinforces that society expectation, it is very difficult to change" – ***Clinician 1***

However, to ensure appropriate expectations across a population of patients, rather than individuals, consistency of messaging from other health professionals around indications for imaging across a collaborative pathway was seen as important.

I think in terms of the other health care professionals, like it's an education thing for the people that who deliver their care at A&E, or in the GP practice, it's, we need to get out to them and say, look, don't set them up with an expectation that they're going to get imaging… So some of its education of them to refer for our expert opinion, rather than referring for scans – ***Clinician 4***

The consistency of message was further discussed in situations where historical professional hierarchies may be perceived. If a referring doctor suggested a scan was required, this belief would prevail in lieu of a clinical opinion from a physiotherapist.

> *"… if that message is coming from a physio, it's more difficult for them to trust it, I think. Whereas…if it came from a doctor, it would have more, a more powerful effect. But there's some people who think, no offence, they say this to me, they go, "No offence, but you're a physio" I need to see the specialist and I'm like, well, I'm the specialist, I see back pain every day, I manage it, I manage it non surgically"* – ***Clinician 4***

> *"GPs can sometimes be quite diagnostic, heavy, or say this is what you need. And still, in today's society, if a doctor says something, there's that element of 'Well, that's what I need, because the doctors said it'. So it can be very difficult and challenging to change that erm perception of expectations when it, when a doctor has said it"* – ***Clinician 3***

Several clinicians highlighted potential strategies to inform the development of a consistent message across local pathways to enable realistic expectations. These included education and dialogue with referrers; information pre-appointment to patient outline what to expect; as well as public health initiatives.

"We could educate the GP as well first of all. That's the big thing. I think education starts from the GP because they are the ones who will call them and tell them that, please tell the patient do not expect the scan. Tell the patient that we are going to be examining them first and then decide if we need a scan" – ***Clinician 8***

"So like a, like a Service website, that maybe has a video or a leaflet that says, erm so you've been referred to physio, this is what you would normally be referred to physio for, this is what we can offer you, this is within our remit. This is why we would do that. So then, there's that sort of digestible information there for them to read in their own time" – ***Clinician 2***

Whilst it was considered possible by the clinicians to influence beliefs on an individual basis, this may be too late.

"Yeah, I just think we're too late to the game in educating them. Like, I think if they grew up with these beliefs, it's quite hard to change people's beliefs when they're older and they're more ingrained" – ***Clinician 4***

The clinicians discussed how greater impact may be seen if beliefs can be influenced prior to symptom development, and in the context of a society with more contemporary beliefs around pain and diagnosis.

"a huge, huge piece of work with the change in the narrative around imaging societally and trying to change that patient's expectation and understanding of what value imaging doesn't have, moving away from it being black and white in terms of diagnostic, your x-ray shows this, this, and they're causing you pain to…so this is what an x-ray or a scan can do and can show us or we got to consider it within the bigger picture" – ***Clinician 6***

"Erm, but it's an old argument is what when does this education start? Does it start in school? Well, maybe…so you have to sort of try and educate the masses, but I don't know where to start" – ***Clinician 2***

Aligned to this was how clinicians would interact with patients that expected a scan as part of their care, particularly in circumstances where there were limited clinical indications. In such circumstances, the majority of clinicians indicated they would seek to understand why the patient wanted imaging, explain the indications for, benefits, and limitations of imaging with a view to alter beliefs and explain why they would not refer for imaging.

"It'd be a case of well, what is it that you're hoping to achieve from getting that image? And would you be happy if I could answer that question without imaging you?" – ***Clinician 2***

Although requesting a scan in such circumstances could be considered the more straightforward action, being less resource intensive in the moment, it was consistently seen as 'kicking the can down the road' either for themselves or another clinician, as the same conversation would be required at some point in the patient's care journey, and this may be more difficult following imaging.

> *"I think in that circumstance probably not, I probably would not request the image in that circumstance. Unless, it was going to move me, the management, the patient's management, and the management process forward then no I wouldn't. Certainly, when I pick up other clinician's patients that have done that, maybe ordered the image because the patient wanted the image…it makes for a really difficult conversation, at that review appt, I think you're just kicking a difficult conversation down the road, and potentially actually making it more difficult"* – ***Clinician 1***

Despite this, the clinicians reflected how there were barriers to having this conversation consistently. The time taken to engage in such a conversation was often longer than it was to request the scan.

> *"If I'm being 100% honest, I'd say that I have done it before. I have done it in the past and may well do it in the future… when you don't necessarily get a huge amount of time anyway and there's that pressure to get through a number of patients, sometimes the easiest thing is think, okay,*

I'll tell you I'm going to send you for this, because that keeps me on track and it gives me another few weeks to think about it. I'd be being dishonest if I told you that I never did it, because I know that I have" – ***Clinician 9***

(Having imaged as the more straightforward option) "It was probably a bit more because I was struggling, and I was sort of pushed for time. But what I learned by doing that was that all I was doing was shifting the hard conversation to the review appointment, which was usually a shorter appointment over a telephone. So yeah, I think you just shifting the hard conversation to another time period" – ***Clinician 2***

The frequency of having these interactions with patients invoked fatigue amongst participants. If the patient did not engage with the message being conveyed by the clinician early in the encounter, they would request the scan:

"I'll try and have that difficult conversation, if they're not on easily, if they're not easily or moderately on board with that so if they are a hard-line stubborn person, and they need a reassurogram, or they feel they need a reassurogram, and then I guess I'll do that as well… but I wouldn't want to" ***– Clinician 4***

The perceived culture of the team, and support provided to the clinician if a patient were to complain about not being referred for a scan was also a factor. This was influenced by the previous experience of clinicians following such circumstances and transferred forward into future interactions.

> *"I've never like been told that in the response to the, the feedback from the complaint, you made a bad clinical decision there. It's always like, oh, we, we probably, let's just do it for them. Erm so, in order to avoid the complaint…they sort of back you a little bit in saying that your clinical decision was right, but let's just do it for them so why let them complain? When I could just, if that's going to be the outcome anyway, I'll just do it so that we don't get a complaint, they'll get the imaging anyway"* – ***Clinician 4***

6.1 Discussion

The purpose of this qualitative study was to fulfil thesis objective **iii** (**see 1.4**) of this thesis; to understand why diagnostic imaging is requested for those with lower back, knee, or shoulder pain and how the imaging findings are used from the perspective of the referring clinician. This qualitative study has identified the factors underpinning the role of diagnostic imaging and in doing so provides new insight into the referring clinician's perspective. From the referring clinician's perspective, four themes were identified; (1) *Power and uncertainty: the clinical gatekeeper; (2) Imaging as part of*

scope expansion before refinement of use with experience; (3) Imaging use requires context with wide-ranging considerations; (4) The influence of patient expectations.

Dealing with uncertainty and managing risk have long been considered as essential skills for medical practitioners (246). A 'medical uncertainty principle' has been proposed that suggests as a doctor becomes more certain of a diagnosis informed using investigations, the health of the patient deteriorates because of the same investigations e.g., the worry of recurrence, and associated stress that may be felt by the patient whilst waiting scan results in someone with an unrelated history of serious pathology (246). Therefore, for investigations to be used appropriately, doctors are trained and expected to be able to tolerate a level of uncertainty. Tolerating uncertainty is a reasonably new concept for physiotherapists that has been brought into focus by the introduction of FCP roles within primary care (247). FCPs are expected to see patients with undifferentiated presentations as the first practitioner in their care journey. In the context of this qualitative study, this is important when considering most participants were APPs. An APP will see a patient following at least an initial appointment by another clinician, who will have screened and assessed the patient as suitable for APP assessment. Despite this, the participants still report difficulty tolerating diagnostic uncertainty.

Diagnostic uncertainty has been defined as a subjective perception of an inability to provide an accurate explanation of the person's health problem (248). Where diagnostic

uncertainty exists, it has been demonstrated that this leads to increased investigations (249). A qualitative investigation exploring the experience of uncertainty amongst physiotherapists working in first contact roles found that this is underpinned by a worry related to missing serious pathology and the possible medicolegal impact for them as an individual (250). The results of this study further corroborate these findings. The uncertainty of the clinician informs a request for diagnostic imaging to provide reassurance to themselves, without equal weighting to the consideration of the potential negative effects on the patient, such as iatrogenesis. These same potential negative effects are however cited as a reason to not investigate to reassure a patient. It would appear the 'medical uncertainty principle' could be widened beyond just doctors, being equally applicable to physiotherapists.

The clinicians within this study all reflected how they increased their scope of practice to include the requesting of imaging as part of their career development, and as a requisite part of the APP role that they were moving in to. Within physiotherapy, expanding scope of practice has historically been synonymous with seniority and 'Advanced Practice', incorporating skills that were traditionally undertaken by doctors such as injecting, prescribing, or requesting imaging. Imaging as a requisite part of the APP role is driven by the pursuit of pathway efficiency, the same task being completed by a clinician that is capable, but not a doctor and therefore potentially less expensive (108).

However, there are other factors to consider and potential unintended consequences when you consider this in the context of the respective career pathways of doctors and physiotherapists. Within this study, a clinician considered themselves to be senior having been qualified for six years; doctors are considered junior until they finish their training and become a Consultant in their chosen specialty. The pathway to becoming a Consultant requires two foundation years before undertaking an eight-year specialty specific training programme. The pursuit of pathway efficiency in turn may be introducing vulnerability to physiotherapists, and an expectation for an inexperienced group to undertake roles and make autonomous decisions for which they are unprepared. Clinicians moving into FCP, even with experience of working as an APP in intermediate care have expressed how they felt unprepared for their role and dealing with the uncertainty that they faced (250). More recently Advanced Practice has been considered as a level of practice, as opposed to a job role, that is characterised by autonomy and complex decision making (251). The clinical implications are clear in that there is a need for physiotherapists to develop strategies that enable them to tolerate risk and manage uncertainty in a way that does not rely upon investigations.

Several strategies have been proposed to help clinicians practice in the context of clinical uncertainty including, discussing openly with patients, and involving patients within the decision-making process (252). This however assumes that there are no barriers to effective communication. In the patient interviews, Participant 1 was a patient that I had consulted, and English was not their first language. As a clinician, I was aware that I had attempted to discuss risks/benefits, the purpose of the scan that was

being requested and had followed this up with educational materials. Despite this, the participant was unable to recall this occurring during his research interview. Within this study, clinicians reflected that a language barrier influences clinical decision making around the use of imaging. This stemmed from the subjective history being weighted more highly by clinicians to inform their clinical reasoning and manage risk. In the context of consulting a patient for whom English was not their first language, clinicians reflected less confidence in terms of the patient understanding what was being asked, and in turn providing an accurate answer. There is potential therefore that those that do not speak English as a first language may be more exposed to the potential negative effects of imaging, contributing to health inequalities (253). Health inequalities are defined as avoidable and systematic differences in health between different groups of people. Racial and ethnic differences have been investigated to determine whether those from a minority ethnic background with LBP were more or less likely to receive guideline-concordant care. The results demonstrate that those from a minority ethnic background are more likely to receive guideline concordant care in relation to medications prescribed and referral for surgery; however, it was not clear whether there is an impact on imaging use (254) The findings within this current study suggest that where a language barrier exists between clinician and patient, this adds to the complexity of the consult and can contribute to clinician uncertainty, resulting in imaging more likely to be used.

The role of patient expectations in influencing the requesting of imaging has previously been outlined, driven by a belief that the results of diagnostic imaging will inform both

diagnosis, treatment, and certainty (249). The findings within this study further corroborate the influence of patient expectations. Patients with non-traumatic knee pain report that clinicians infrequently discuss diagnosis and how this creates a sense of confusion and feeling disbelieved, with trust placed in diagnostic imaging to provide both reassurance and validation (225,255). If patients do not feel believed or their experience validated without imaging, the clinical implication is to ensure that clinicians are aware of this gap and develop the capability to validate a person's pain experience without needing to rely upon diagnostic imaging (255). This could be achieved through a comprehensive physical examination (249) or through focused development of communication skills and techniques, that provides the clinician with a framework that enables a patient to feel like they have been understood and believed (256). With these implications embedded across the pathway, more appropriate expectations could be facilitated within each clinical interaction.

6.1.1 Strengths and Limitations

The breadth of the sample in terms of age, years qualified and years in role are strengths given the phenomenon of interest and in turn aid transferability. However, all clinicians were physiotherapists who either worked in intermediate care, or within a split role between primary and intermediate care. With no clinicians recruited that purely worked as an FCP in primary care, or outside of this professional group, this should be considered when applying the findings within such a context.

Confirmability and credibility were enhanced through member checking and peer debriefing. The member checking process confirmed accuracy of the analysis with no suggested changes from participants, whilst peer debriefing in this study was achieved in the form of supervision to test insight, interpretation, and analysis resulting in topic guide adaptation and informing the purposive sampling strategy. The use of reflexive journalling throughout the study supports transferability and dependability of the results. Two prominent areas of reflexivity relate to my own professional tension when requesting imaging within my clinical practice, and my insider role as an interviewer, with participants for whom I represent a senior figure within their employing organisation.

When I started requested diagnostic imaging as part of my practice, I felt a professional tension as a physiotherapist. A tension related to a sense of guilt that I was unable to sufficiently help this person. As such, I was mindful of my wording when interviewing to ensure that I asked questions in a way that was context neutral and shared this tension that I felt with the supervisory team in attempt to mitigate projection onto participants. This same professional tension or sense of guilt when requesting imaging did not manifest throughout the interviews, suggesting that this reflexive activity and subsequent mitigation had been successful.

An insider is defined as a researcher who shares a similar background to the population, they are studying (226). Within this study clinicians were recruited from one organisation. This is the same organisation in which I am employed, and where I hold a senior leadership position. As such, not only am I a practicing clinician within the same

setting as the participants, but also someone to whom the participants may not feel comfortable, or able to speak openly around their practice for concerns around how they be perceived or considered. They may be concerned that their interview does not remain confidential or may answer based on what they feel they should say, rather than what they believe. Whilst these represent risks, there are also benefits to being an insider. These include being accepted by the participants as someone who will understand their experience, greater familiarisation with the topic, and the ability to understand and explore nuanced or unanticipated reactions or directions (257).

To harness the benefits and to mitigate the risk, a variety of measures were implemented to frame the context of the interview, to promote openness and reassure confidentiality. These are detailed in Chapter 5. Within the interviews, it was apparent that these measures had been effective with insight shared openly that would not be considered 'good practice' by the organisation and delineated from the promoted ethos and designed pathways. Examples of this include:

> *"I'll try and have that difficult conversation…if they're not easily or moderately on board with that so if they are a hard-line stubborn person, and they need a reassurogram, or they feel they need a reassurogram, and then I guess I'll do that"* – ***Clinician 4***

"(Do you ever find yourself ordering a scan because it's easier than having a difficult conversation) If I'm being 100% honest, I'd say that I have done it before. I have done it in the past and may well do it in the future." –

Clinician 9

6.1.2 Conclusions of the clinician interviews

Clinicians demonstrate a lack of confidence and capability to manage risk and tolerate uncertainty, often using imaging as a strategy to reassure themselves in such circumstances. Despite this, clinicians do reflect that other options exist to help tolerate uncertainty without relying on scans. Whilst patient expectations influence how imaging is used, with clinicians reflecting that they may use imaging to obtain patient buy in, they also highlight how they will engage in what they consider a challenging conversation if they do not feel this expectation is appropriate. In these situations, they often adopt a gatekeeper role to whether imaging is in turn requested. Imaging use requires context, such as an expectation that the result will change management and that the patient would be open to undergoing the subsequent treatment. The use of imaging by clinicians is refined with experience.

This chapter presented the results of the clinician interviews and how from a clinical perspective, the use of imaging requires wide-ranging considerations that are refined with experience. Patient expectations do influence imaging use however, clinicians will adopt a gatekeeper role if they feel these expectations are not appropriate. In the next

chapter, an overall discussion outlining how the findings of this programme of work has addressed the thesis aims, and will include recommendations for practice, research, and policy.

Chapter 7 – Discussion, Recommendations and Conclusion

Summary

This chapter outlines how the findings of this programme of work address the thesis aims. The extent to which each aim and objective has been met will be discussed. Through consideration of the findings of both scoping reviews and qualitative investigations, the extent to which new knowledge has been generated is outlined alongside recommendations for practice, policy, and future research.

7.0 How the findings have addressed the thesis aims

The aims of this thesis have been achieved and new knowledge generated in relation to an enhanced understanding of both why and how imaging is used within clinical practice. In the context of increasing diagnostic imaging use being seen within the NHS, the primary aim of this PhD was to better understand the reasons for requesting imaging for patients with common MSK pain conditions, including lower back, knee, and shoulder pain. The insight from the scoping review of CPGs (Chapter 2), corroborated by the information contained within public-facing websites (Chapter 3), outline that imaging is requested to detect specific or serious pathology, or in circumstances where the person's symptoms persist and the result it expected to change management. Clinician interviews broadly demonstrated alignment with CPGs, rationalising the requesting of imaging to detect serious pathology or specific pathology that would be amenable to invasive intervention, and in turn changing management (Chapter 6). Within the patient interviews, there were clear beliefs and expectations that imaging was sought to inform a diagnosis,

especially in the context of perceived limitations in the clinicians ability to perform and effectively communicate a comprehensive assessment (history and examination) to guide management, particularly where symptoms had persisted (Chapter 5).

A secondary aim was to understand how the imaging findings are used; including how such information might guide treatment and referral for further clinical opinion. The scoping review of CPGs gives limited insight into how the imaging findings should be used beyond to 'change management' however, the clinician interviews subsequently demonstrated how this was open to interpretation. The scoping review of public-facing websites provided further insight, suggesting that imaging should be used in context of the individual patient presentation, as part of the clinical assessment to inform diagnosis and management. This contextualisation of how imaging should be used with individual patients was aligned with the reasoning demonstrated by clinicians, and how patients expected to be treated, although patients felt the extent to their involvement in the decision to image or not, was limited. The patient interviews suggested that imaging is mostly used to make sense of symptoms and to provide reassurance when symptoms persisted, if symptoms persisted, patients expected imaging as part of their care to provide certainty. When patients express an expectation of imaging, this influences clinical decision making. Imaging to provide reassurance to clinicians when they were not certain of the diagnosis was evident in the clinician interviews. Underpinning these aims were several objectives, the degree to which each of these objectives has been achieved and the impact of this programme of work is now discussed.

7.0.1 Objective one

The first objective was to review the current recommendations for requesting diagnostic imaging within CPGs that may be used to inform clinical decision making. This objective was met with the scoping review described in **chapter two**. The findings of this scoping review outlined that the routine use of diagnostic imaging for those with non-traumatic LBP, knee or shoulder pain is discouraged. Diagnostic imaging within a primary care or intermediate care setting within UK practice should be reserved for cases where:

- specific pathology is suspected or;
- serious pathology is suspected or;
- where the person is not responding to initial non-surgical management and the result is expected to change clinical management of that person's presentation.

This scoping review was a comprehensive review of CPGs and recommendations for use of diagnostic imaging within UK primary and intermediate care, particularly contributing new knowledge to the evidence base in relation to the similarities and differences between CPG recommendations for spinal, upper limb, and lower limb conditions.

7.0.2 Objective two

The second objective was to review the current recommendations for requesting diagnostic imaging contained within publicly available websites. This objective was met with the scoping review described in **chapter three**.

This review identified 48 public-facing websites that provided written information or recommendations for the use of diagnostic imaging in adults with LBP, knee, or shoulder pain. The written information or recommendations contained with the websites were largely consistent. The key messages contained within public-facing websites regarding the use of diagnostic imaging outlined what patients should expect in terms of imaging modality and the experience when undergoing lesser common modalities. Where imaging is used, it should be to inform diagnosis and management within the context of the clinical presentation, rather than in isolation. The findings of this scoping review demonstrated that the recommendations for imaging within public-facing websites were largely consistent, and in accordance with the recommendations within CPGs. A particular strength of this review was the involvement of a Patient and Public Involvement and Engagement (PPIE) group to design the search strategy. Through this scoping review new knowledge was contributed through the mapping of information and recommendations within public-facing websites for the use of diagnostic imaging.

7.0.3 Objective three

The third objective was to understand why diagnostic imaging is requested, and how the findings are used within clinical practice from the perspective of the referring clinician and the patient. This objective was met with the qualitative studies with patients and clinicians described in **chapters four (methods), five and six (findings and discussion)** of this thesis. This was the first qualitative investigation within a UK-context that specifically aimed to explore beliefs related to the use of diagnostic imaging for lower back, knee, and shoulder pain, contributing new knowledge to the evidence base.

The findings demonstrated that the value of undergoing diagnostic imaging was considered wide-ranging from a patient perspective **(chapter 5)** in attempt to help make sense of their symptoms. Despite this, patients did not feel fully informed or involved in the decision-making process. Additionally, clinicians **(chapter 6)** demonstrate a lack of confidence and capability to manage risk and tolerate uncertainty, often using imaging as a strategy to reassure themselves in such circumstances. Despite this, clinicians do reflect that other options exist to help tolerate uncertainty without relying on scans. Whilst patient expectations influence how imaging is used, with clinicians reflecting that they may use imaging to obtain patient buy in, they also highlight how they will engage in what they consider a challenging conversation if they do not feel this expectation is appropriate. In these situations, they often adopt a gatekeeper role to whether imaging is in turn requested. Imaging use requires context, such as an expectation that the result will change management and that the patient would be open to undergoing the subsequent treatment. The use of imaging by clinicians is refined with experience.

7.0.4 Objective four

The final objective was to propose recommendations for clinical practice, research, and policy related to the use of diagnostic imaging for common MSK pain conditions. Whilst such recommendations are implicit based upon the focus throughout this thesis, these **will now** be clearly outlined.

<u>Recommendations for clinical practice</u>

Routine use of diagnostic imaging for those with non-traumatic LBP, knee or shoulder is discouraged **(section 2.4**). Diagnostic imaging within a primary care or intermediate care setting within should be reserved for cases where:

- specific pathology is suspected or;
- serious pathology is suspected or;
- where the person is not responding to initial non-surgical management and the result is expected to change clinical management of that person's presentation.

Frequently, clinicians reflect on how in the context of uncertainty and clinical risk, they rely on imaging for reassurance **(section 6.1).** There is a need for physiotherapists to develop strategies that enable them to tolerate risk and manage uncertainty in a way that does not rely upon investigations. Possible strategies for this include a focus on the development of communication skills, discussing the uncertainty with patients and involving them in the decision-making process (252) It is evident from the patient interviews that people with LBP, knee, and shoulder pain would welcome such involvement (**section 5.0.3)**. Practical ways this could be achieved include the use of patient decision aids, or through use of the NICE-recommended "three-talk model"; this model involves describing options, offering choice, and exploring patient preferences as part of the decision making process (258). Additionally, with patients reflecting how the value of imaging for them includes both validation and reassurance **(section 5.0.1)**, enhanced communication capability will enable clinicians to ensure patients feel listened to and understood, without relying upon imaging.

Recommendations for policy

When clinically reasoning whether to refer for a diagnostic image, clinicians outline a requirement for the result of that image to change management **(section 6.0.3)**. This consideration in practice is aligned to the recommendations contained within CPGs. However, what is understood by 'change management' is open to interpretation. Clinicians reflected on this and how in its current form, a diagnostic image could be requested and justified as working within this recommendation for almost all patients. Therefore, future policy and guidelines could include a statement on the intent that underpins this recommendation, to enable consistent application in practice. For example:

> *When symptoms persist despite appropriate initial treatment and management, diagnostic imaging should only be considered where the findings are expected to change management. In this context, changing management refers to a high-clinical suspicion of identifying a pathoanatomical target for which invasive (injection or surgery) intervention has been shown to be both efficacious and effective, in a patient willing and suitable to undergo this intervention.*

New models of healthcare are currently evolving across the NHS, including the expansion of FCP roles and services, aligned to the NHS Long Term Plan, which changes the historical primary, intermediate, secondary care definitions (109). The ability to request imaging has been acknowledged as a core capability for FCPs (259).

An FCP represents a specialist clinician, working at the front end of the patient pathway, within primary care. Current policy and guideline recommendations are written with either care setting, or level of expertise considered **(section 2.3).** For example, what should be offered within primary care, or what should only be offered within a specialist setting. Local pathways and radiology provision are then designed, aligned to these recommendations. As such, FCPs currently are situated in a gap within CPG recommendations. Future CPGs relevant to UK clinical practice for MSK pain should ensure they reflect contemporary, rather than historical healthcare models e.g., outlining what imaging would be appropriate for an FCP to request in primary care may differ to what would be appropriate for a GP to request.

The use of diagnostic imaging has increased within the NHS, with the demand from primary care contributing to this increase (15) **(section 1.2)**. This increasing use is seen worldwide but has not demonstrated an improvement in clinical outcomes (32). With it being recognised that unnecessary imaging can be harmful, there has been a focus on optimising diagnostic imaging use, typically through attempts to reduce the amount of diagnostic imaging performed. As the NHS attempts to recover service provision from COVID-19 pandemic related disruptions, several targets have been introduced. One of these targets relates to diagnostic imaging, the NHS being instructed to increase diagnostic activity to 120% of pre-pandemic levels, with additional funding provided to enable the expansion of community diagnostic centres (260). These targets however do not refer to increased appropriate diagnostic activity, only increased diagnostic activity. More may not necessarily mean better. This target represents a risk to both current and

future clinical practice, for example, encouraging increased imaging referral behaviours and appears in tension to pre-pandemic imaging optimisation initiatives. When considering NHS service recovery, policy makers should consider opportunities to recover ‘back to better’, to restore NHS services of higher quality than they were pre-pandemic rather than encouraging doing more of the same.

Aligned to the above, there is a tension between clinicians and healthcare systems seeking to reduce diagnostic imaging use by facilitating appropriate use and eliminating unnecessary imaging, and patient and public beliefs at a societal level around the perceived wide-ranging value of the scan (**section 5.0.1**). To reduce this tension and seek to align perspectives, there is a need for deliberate intervention that seeks to change widely held societal beliefs around the utility of diagnostic imaging. Policy makers should consider achieving this through targeted public health campaigns, and review of educational curricula within schools to ensure contemporary understanding of pain, diagnosis, and in turn imaging utility **(section 5.1).** Previous public health campaigns hosted within health service waiting rooms in Australia focusing on the overuse of diagnostic imaging have been shown to successfully raise awareness, but also to provoke negative reactions such as anger and mistrust (261). It is possible that these negative reactions were invoked with the campaign focusing on a population that are already seeking care. Regarding intervention within schools, to date, studies have focused on short-term outcomes however, the findings do suggest that it is possible to quickly change pain beliefs and openness to more holistic management of pain in high school students in the UK (262). Longer term impact is however currently unknown.

Recommendations for future research

In the context of increasing imaging use worldwide (25) and an ever-growing burden of non-traumatic MSK pain, alongside rapidly developing technological advances e.g., artificial intelligence, there are numerous areas of research that could be suggested. These include the development of clinical support tools to support guideline implementation to practice or investigating the effectiveness of a public health campaign **(section 5.1)** in changing societal beliefs around imaging utility. However, with reference to the focus of this thesis, three specific areas are suggested.

CPGs recommend against the use of ultrasonography as the first line investigation for knee or shoulder pain **(section 2.2.5).** This should be considered within the context of rapidly expanding uptake of Point of Care Ultrasound (POCUS) amongst physiotherapists (24). The increased use appears to be due to a desire for quicker diagnostic information in real time, to assess, diagnose, screen or guide treatment (24). This thesis has focused on the requesting of diagnostic imaging that involves a clinical decision to be made, prior to referring to a radiology department for that imaging to take place **(section 1.2)**. Future research should seek to understand the impact and effectiveness of POCUS on clinical outcomes.

The subsequent two areas relate to evaluating possible interventions designed to support appropriate use of diagnostic imaging. The first evaluating the effectiveness of developing personalised ‘contracts’ with patients, informed by known prognostic factors

(section 6.0.4). The second, with a commitment and expectation for shared decision making to be implemented across the NHS as part of personalised care, there is a need to establish the effectiveness of implementing and encouraging the use of shared decision making within this context **(section 5.1)**.

7.1 Strengths and Limitations of this thesis

This thesis should be considered in the context of both its strengths and limitations. The two scoping reviews, and qualitative investigation were all reported in alignment with the relevant reporting guideline. This has been shown to enhance readability as well as ensuring that the required information to enable a variety of readers to engage meaningfully is available, whether that be a clinician to inform clinical reasoning and decision making, or a researcher looking to replicate the primary studies (263). A further strength is that **Chapter 2 – 6** have all been shaped by external peer review. **Chapters 2** and **3** have been shaped through publication in peer reviewed journals (214,264) whilst **Chapters 4 – 6** were shaped initially through the successful award of a Scheme B research grant from the CSPCT and subsequent reporting of progress and results.

As well as strengths, there are some limitations. The thesis was set in a UK context and therefore the results may not be representative of imaging use in other countries and their healthcare setting. Further, the qualitative investigation recruited from a single organisation which may in turn limit transferability. However, with the participants recruited from multiple services, working in different pathways, in different parts of

England, this limitation may be somewhat mitigated. A final limitation is that this thesis focused on the process of using imaging from the perspective of a clinician referring into a radiology provider to obtain an image. Increasingly, clinicians are performing the imaging themselves as part of a consultation (24), it is not known to what extent the findings of this thesis apply within such a context.

7.2 Conclusion of thesis

This PhD thesis has offered new insight into understanding why diagnostic imaging is requested, and how the imaging results are used in clinical practice for those with LBP, knee, and shoulder pain. Two scoping reviews were conducted and reported which summarise CPG recommendations for imaging use and demonstrate that public-facing website information with reference to imaging use aligns with best available evidence. Two subsequent qualitative investigations provide insight from the perspective of both the referring clinician and patient. The insight and new knowledge outlined within this thesis enabled clear recommendations for clinical practice, policy, and future research.

Despite the new knowledge presented in this thesis, there remains a need to enable appropriate use of diagnostic imaging within clinical practice. Whilst some questions have been answered within this thesis, there are still unanswered questions as to how this could be best achieved. However, a foundation has been established upon which further knowledge can be developed.

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Appendix 1 – Published CPG Scoping Review

Received: 8 July 2020 | Accepted: 10 July 2020
DOI: 10.1002/msc.1497

WILEY

LITERATURE REVIEW

Guidelines for the use of diagnostic imaging in musculoskeletal pain conditions affecting the lower back, knee and shoulder: A scoping review

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Funding information
National Institute for Health Research (NIHR), Grant/Award Number: PDF-2018-11-ST2-005; Manchester Metropolitan University; Keele University, Grant/Award Number: ACORN PhD Studentship

Abstract

Background: Musculoskeletal (MSK) pain is one of the most common reasons for primary care consultation, particularly pain in the lower back (LBP), knee and shoulder. The use of diagnostic imaging for MSK pain is increasing, but it is unclear whether this increase is justified on the basis of clinical practice guideline (CPG) recommendations.

Aim: To identify and map the content of CPGs that informs the use of diagnostic imaging in those with nontraumatic LBP, knee and shoulder pain in primary and intermediate care in the UK.

Design and Setting: A scoping review of CPGs.

Methods: This scoping review was conducted and is reported in accordance with PRISMA guidance. A broad search strategy included electronic searches of MEDLINE, CINAHL, PsychINFO and SPORTDiscus from 2009 to 17 April 2019. This was conducted alongside a search of guideline repositories and was combined with a snowball search of Google, relevant professional bodies and use of social media.

Results: 31 relevant CPGs were included. Routine use of diagnostic imaging for those with nontraumatic LBP, knee or shoulder pain is generally discouraged in primary care or intermediate care. Diagnostic imaging should be reserved for when specific or serious pathology is suspected or where the person is not responding to initial non-surgical management and the imaging result is expected to change clinical management decisions.

Conclusion: Diagnostic imaging should not be routinely requested in primary or intermediate care for nontraumatic LBP, knee or shoulder pain. CPGs do not justify the increasing imaging rates in the UK for MSK pain.

KEYWORDS
clinical practice guidelines, knee pain, lower back pain, musculoskeletal, scoping reviews, shoulder pain

1 | INTRODUCTION

Musculoskeletal (MSK) pain conditions are one of the most common reasons for primary care consultation (Jordan et al., 2010), with the highest prevalence for low back (LBP), shoulder and knee pain (Jordan et al., 2010; Urwin et al., 1998). The majority of these presentations are nontraumatic and often cannot be attributed to a specific structural or biomedical diagnosis. In turn, these are regularly allocated a nonspecific label (Jordan et al., 2010).

For nearly all of those presenting with LBP, knee or shoulder pain, the recommended first-line clinical care is nonsurgical (Lin et al., 2019) and includes advice and education, exercise, activity modification and pharmacological interventions. More invasive treatments such as injections or surgery are reserved for a smaller proportion of patients with either clear pathology that justifies a particular type of invasive intervention or for patients whose symptoms persist following recommended nonsurgical treatment (Lin et al., 2019). Although this 'stepped care' approach is advocated, the indications for proceeding to surgery in those that have not previously responded to nonsurgical management have been challenged (Beard et al., 2018; Lurie et al., 2015; Sihvonen et al., 2018).

The decision to request diagnostic imaging (DI) is increasing in early primary care consultations. Between 2014 and 2019, there has been a 16% increase in the use of radiology within the National Health Service (NHS). This level of demand has been acknowledged as a challenge within the NHS (NHS England, 2019b). A recent systematic review (SR) and meta-analysis investigated global rates of imaging for LBP over the 10-year interval from 1995 to 2015. This review estimated that 24.8% of patients with LBP that present to primary care currently will undergo DI and found that the rate of complex imaging (magnetic resonance imaging [MRI] and computed tomography [CT] scan) has increased by 50% for those consulting in primary care or emergency departments (Downie et al., 2019). Despite this increase in investigation rate, for those presenting with acute or subacute LBP in primary care, no difference is seen between those who received imaging and those who received usual care without imaging (Chou, Fu, Carrino, & Deyo, 2009) with regards to pain, function or quality of life at any time point up to 12 months (Chou et al., 2009). Similar findings have been demonstrated for knee pain (Karel, Verkerk, Endenburg, Metselaar, & Verhagen, 2015) and shoulder pain (Bradley, Tung, & Green, 2005).

In the context of a rising prevalence of imaging, the problems associated with the risk of misuse of DI are well recognised. These include a potential waste of finite health care resources, poorer perceived prognosis and an increased chance of undergoing surgery (Darlow, Forster, O'Sullivan, & O'Sullivan, 2017; Webster, Choi, Bauer, Cifuentes, & Pransky, 2014). Furthermore, there is considerable uncertainty about how scan findings, for example, ultrasound scan (USS) evidence of a rotator cuff tear (Girish et al., 2011) or evidence of a prolapsed intervertebral disc on an MRI scan (Brinjikji et al., 2015), correlate with patient symptoms. Despite this uncertainty and questionable added value, scan results are perceived by patients as authoritative (Cuff & Littlewood, 2018). Given that a substantial proportion of primary care consultations involve MSK pain presentations and 90% of all consultations occur within primary care (Network, 2019), there is a clear need to better understand the reasons for the increasing use of DI.

Clinical practice guidelines (CPGs) are 'statements that include recommendations intended to optimise patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options' (Graham, Mancher, & Miller Wolman, 2011). They are a key source of information about the appropriate use of DI (Darlow et al., 2017). The aim of this study was to identify, summarise and identify similarities and differences between CPGs that inform UK clinical practice with respect to DI (X-ray, MRI, and USS) for nontraumatic LBP, knee and shoulder pain.

2 | METHODS

This scoping review was designed with reference to guidance described by the Joanna Briggs Institute (Peters, Godfrey, Khalil, et al., 2015). An attempt was made to register the protocol with PROSPERO; however, scoping review protocols are not currently accepted. Any deviations from the protocol are outlined below.

2.1 | Eligibility criteria

CPGs were included that:

- were either developed in the UK or intended for wider regional use that inform MSK clinical practice within UK primary or intermediate care.
- met the definition of a CPG: statements that include recommendations intended to optimise patient care that are informed by an SR of evidence and an assessment of the benefits and harms of alternative care options.
- provide recommendations on the use of DI in adults with nontraumatic LBP, knee and shoulder pain.
- were published between 2009 and 2019 and accessible in the public domain.

2.2 | Search strategy and information sources

The full electronic search strategy can be found in Tables S1–S22.

A comprehensive search of key databases (MEDLINE, CINAHL complete, PsycINFO and SPORTDiscus) was undertaken from 2009 to 17 April 2019. The full MEDLINE search strategy for LBP can be found in Table 1. This was complemented by a search of CPG repositories as well as a 'snowball' search of the top 50 results from a Google search and the websites of professional bodies relevant to primary care MSK practice. A request for CPGs that met the inclusion criteria was circulated through the same professional bodies as well as through the social media platform Twitter.

TABLE 1 Search terms—LBP (Medline)

1. (in title/abstract) MH "Practice Guidelines"
2. (in title/abstract) OR Guideline* OR consensus OR recommendations
3. (title/abstract) AND Lumb* or LBP or NSLBP or CNLSBP or non-specific or low* or back or spin* or radic* or stenosis or facet* or inf* or fracture or scoliosis or cancer* or malign* or cord or cauda or CES or spond* or OA or osteo*
4. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 to date of search, English language, guidelines, consensus development conference, practice guideline

2.3 | Selection of sources of evidence

All titles identified were screened by one reviewer (A. C.) and duplicates removed using Mendeley reference management software following a pilot of the selection criteria and process by authors A. C. and R. T.

Following this initial screening, if abstracts were available, they were reviewed independently by two reviewers (A. C. and R. T.), who applied the selection criteria. Where a decision could not be made on eligibility, or if an abstract for the CPG was not available, the full CPG document was obtained.

Full CPG documents were reviewed independently by two reviewers (A. C. and R. T.), and if it was not clear whether the identified document met the criteria for definition as a CPG, then the producing organisation (or authors if there was no producing organisation identified) were contacted for further information. In cases of no response to the request for further information and following reminders, the document was excluded.

Finally, the reference list of all selected CPGs was hand searched by one reviewer (A. C.).

2.4 | Data charting process

The relevant characteristics of the included CPGs and the key data items relevant to the review objectives were recorded in a charting table.

Data extraction was first tested, independently, by two reviewers (A. C. and R. T.) using five included CPGs. Changes were agreed upon by both reviewers and implemented including the removal of the columns titled 'development process' and 'concept e.g. imaging modality'.

One reviewer (A. C.) was responsible for charting the results, and these were verified by a second reviewer (R. T.).

2.5 | Critical appraisal of individual sources of evidence

An assessment of the rigour of the development process was performed through a modification of the Appraisal of Guidelines for Research and Evaluation (AGREE) II tool. All included CPGs were appraised using the third domain of the AGREE II tool 'Rigour of Development'; the AGREE II tool does not provide cut-off scores for whether a CPG is high or low quality; however, previous reviews have utilised this domain as an important indicator of CPG quality. If a CPG scored ≥50%, then the CPG was deemed high quality (Lin et al., 2018).

2.6 | Synthesis of results

When all results were charted, a narrative synthesis was undertaken to provide an overview of recommendations. A narrative synthesis refers to the process of combining, outlining and summarising the recommendations via a textual approach (Popay et al., 2006). Through this synthesis, similarities and differences across the CPGs were identified.

3 | RESULTS

3.1 | Selection of sources of evidence

A total of 12,775 citations were identified through the search strategies. Following the study selection process, 31 CPGs met the inclusion criteria (Table 2). Twenty-six citations were excluded at full document stage, and the reasons for exclusion are outlined in brief within Figure 1.

3.1.1 | CPG origin

The majority of included CPGs were developed in the UK (n = 19), followed by development as part of a continental (European) workforce (n = 9) and international workforce development (n = 3).

3.1.2 | Regional MSK pain presentations

The included CPGs were equally divided between those for a specific MSK pain presentation (n = 16) with LBP (n = 5), knee (n = 8) and shoulder pain (n = 3) and those for a regional pain condition that has the potential to present as LBP, knee or shoulder pain (n = 15).

3.1.3 | CPG rigour of development

The majority (27/31) of the included CPGs were deemed to be of high quality; the common areas of guideline development lacking rigour were balancing the benefits of recommendations alongside risks, harms or side effects; undergoing an external consultation period for stakeholder input and providing clarity on any intended updates (Table 2).

TABLE 2 This table provides an overview of CPGs included within the scoping review

Authors	Year	Development Group, e.g., NICE	Body site/regional condition	Origin	AGREE II
Ward et al. (2016)	2016	NICE	LBP	UK	91%
NICE CKS—LBP (NICE, 2018a)	2018	NICE	LBP	UK	50%
NICE CKS—Sciatica (NICE, 2018c)	2018	NICE	LBP	UK	50%
NICE CKS—Ankylosing spondylitis (NICE, 2013)	2013	NICE	LBP	UK	51.7%
White et al. (2014)	2014	NICE	LBP	UK	78.6%
Zhang et al. (2010a)	2010	EULAR	Knee pain	Europe	57.1%
Price et al. (2017)	2017	BOA	Knee pain	UK	26.7%
Sakellariou et al. (2017a, 2017b)	2017	EULAR	Knee pain	Europe	64.2%
Fernandes et al. (2013)	2017	EULAR	Knee pain	Europe	57.1%
Crossley et al. (2016)	2016	Patellofemoral Pain Research Retreat	Knee pain	International	53.5%
Barton, Lack, Hemmings, Tufail, and Morrissey (2015)	2015	N/A	Knee pain	International	57.1%
McAlindon et al. (2014)	2014	OARSI	Knee pain	International	60.7%
NICE CKS (NICE, 2017a)	2017	NICE	Knee pain	UK	48.2%
Hanchard et al. (2011)	2011	CSP	Shoulder pain	Frozen shoulder	71.4%
Dejaco et al. (2015)	2015	EULAR	Polymyalgia rheumatica (shoulder pain)	Europe	75%
NICE CKS (NICE, 2017b)	2017	NICE	Shoulder pain	UK	46.4%
Compston et al. (2017)	2017	National Osteoporosis Guideline Group	Osteoporosis	UK	62.5%
Ralston et al. (2015)	2015	SIGN	Osteoporosis	UK	66%
Lems et al. (2017)	2016	EULAR	Osteoporosis	Europe	50%
McVeigh et al. (2017)	2017	NICE	SpA	UK	80%
Mandl et al. (2015)	2015	EULAR	SpA	Europe	41%
NICE CKS (NICE, 2018b)	2018	NICE	OA	UK	51.7%
Conaghan et al. (2014)	2014	NICE	OA	UK	83.9%
Ward et al. (2018)	2018	NICE	RA	UK	89.2%
Colebatch et al. (2013)	2013	EULAR	RA	Europe	57.1%
Richette et al. (2017)	2016	EULAR	Gout	Europe	55.2%
Richette et al. (2019)	2018	EULAR	Gout	Europe	50%
Hui et al. (2017)	2017	BSR	Gout	UK	53.5%
Hajioff et al. (2015)	2015	NICE	Malignancy	UK	94.6%
Ralston et al. (2019)	2019	Paget's Association UK	Paget's disease	UK	75%
Remedios et al. (2017)	2017	RCR	Miscellaneous	UK	64.2%

Abbreviations: AGREE, Appraisal of Guidelines for Research and Evaluation; BOA, British Orthopaedic Association; BSR, British Society of Rheumatology; CKS, Clinical Knowledge Summary; CPG, clinical practice guideline; CSP, Chartered Society of Physiotherapy; EULAR, European League Against Rheumatism; LBP, lower back pain; NICE, National Institute for Health and Care Excellence; OA, osteoarthritis; OARSI, Osteoarthritis Research Society International; RA, rheumatoid arthritis; RCR, The Royal College of Radiologists; SIGN, Scottish International Guidelines Network; SpA, spondyloarthropathy.

3.1.4 | Recommendations on the use of DI in those with LBP, knee and shoulder pain

The majority (21/31) of the included CPGs made recommendations on the use of DI within primary and intermediate care (Tables S23–S26).

3.2 | Synthesis of Results

3.2.1 | Low back pain

Routine DI is not recommended within primary care or intermediate care, in either nonspecialist (e.g., general practice [GP]) or specialist

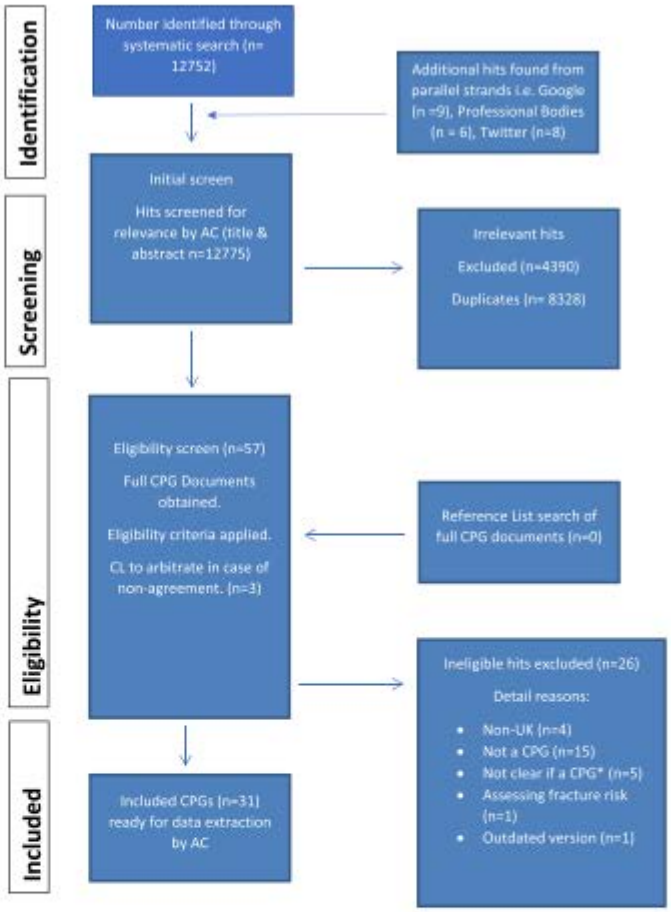

FIGURE 1 Flowchart outlining the selection process for clinical practice guideline (CPG) inclusion within the scoping review of CPGs [Colour figure can be viewed at wileyonlinelibrary.com]

(e.g., Musculoskeletal Interface Clinic) settings. In the absence of suspected serious pathology, imaging is not recommended within nonspecialist settings but rather should be reserved for cases in whom serious pathology is suspected. Within a specialist setting, DI should be reserved for cases for whom it is likely to change clinical management decisions.

The use of X-ray is discouraged in those with LBP unless a fracture or axial spondyloarthropathy (SpA) is suspected. Where there is a suspicion of axial SpA, if sacroiliitis is not demonstrated and suspicion remains, the recommendation is to perform an MRI of the sacroiliac joints. The National Institute for Health and Care Excellence (NICE) SpA guidelines (McVeigh et al., 2017) also recommend the addition of a whole spine MRI; however, the European League Against Rheumatism (EULAR) guidelines (Mandl et al., 2015) do not recommend this.

The majority of CPGs relevant to knee pain focus on knee osteoarthritis (OA); those CPGs for patellofemoral pain (PFP) make no recommendations on the use of DI. Knee OA is typically considered a clinical diagnosis based on age ≥45 years, activity related joint pain and absence of significant morning stiffness. Routine imaging is not recommended for patients with suspected knee OA or during follow up of those with known OA.

The recommendations are to consider the use of DI to exclude alternative presentations in atypical presentations, such as suspected gout or if there is a sudden clinical deterioration. In such circumstances, an X-ray is recommended as the initial investigation. If peripheral SpA or malignancy are suspected, then it is recommended that a USS and/or MRI is considered.

3.2.3 | Shoulder pain

Routine imaging is not recommended for those with shoulder pain. If movement is significantly restricted, symptoms are not improving or if

suspecting serious pathology, then a two-view X-ray is recommended. USS and MRI are usually not recommended for those with shoulder pain unless gout or malignancy is suspected.

3.2.4 | Similarities between CPGs

The recommendations of the CPGs included are similar. The routine use of DI for those with nontraumatic LBP, knee or shoulder pain is discouraged. In clinical circumstances where serious pathology is suspected or where the person is not responding to initial conservative management and the imaging result is expected to change management decisions, then DI is indicated.

3.2.5 | Differences between CPGs

The differences are concerned with modality and clinical setting. The use of X-ray in those with LBP is discouraged unless there is a clinical suspicion of a specific pathology, for example, spinal fracture. In those with knee or shoulder pain, an X-ray is encouraged as the initial investigation.

The recommendations within the guidelines are sometimes written with the care setting in mind, for example, what should be considered within primary care (Price et al., 2017), whereas others are written with the level of expertise in mind, for example, specialist settings (Ward et al., 2016) as opposed to where that care episode takes place.

4 | DISCUSSION

4.1 | Summary

The aim of this scoping review was to identify and map the content of CPGs relevant to UK clinical practice in primary and intermediate care, specifically regarding the use of DI for adults with nontraumatic LBP, knee and shoulder pain. To date, this represents the most up to date and comprehensive review of CPGs and recommendations regarding DI within these care settings for these MSK pain presentations. The routine use of DI for those with nontraumatic LBP, knee or shoulder pain is discouraged across CPGs. DI should be reserved for where serious pathology is suspected, the person is not responding to initial conservative management or the imaging result is expected to change management decisions.

The CPGs for LBP consistently recommend against the use of X-ray unless there is a suspicion of specific pathology. This differs to the CPGs for knee or shoulder pain where the use of X-ray as a first line investigation, albeit for a minority of cases, is recommended. A possible reason for this may be that X-ray findings of peripheral joints may alter the management plan to a greater extent than in the spine. A spinal fracture is usually managed for pain relief in the absence of neurological signs with surgical options being limited (McCarthy & Davis, 2016). In contrast, in peripheral joints, an X-ray may inform the decision to refer for orthopaedic opinion for consideration of more invasive intervention such as arthroplasty.

4.2 | Strengths and limitations

To date, this represents the most up to date and comprehensive review of CPGs and recommendations for use of DI within UK primary and intermediate care settings. The strengths of this scoping review include conduct in accordance with good practice as recommended for the conduct of scoping reviews (Peters, Godfrey, McInerney, et al., 2015) and the methods have been reported clearly, allowing for replication. Previous scoping reviews (Lowe et al., 2018) have demonstrated how the use of novel social media can complement a search strategy to increase the reach and totality of a search. Using Twitter impressions can act as a measure of reach within those using Twitter as a means of continuing professional development (CPD). Within the 14-days that the tweet involved within the search strategy was live, the analytics demonstrate that it was retweeted by 73 people and that 21,375 Twitter users saw the tweet. The inclusion of the tweet as part of the search strategy identified eight additional hits that were not identified from the more traditional means of searching, two of which were included within the review. This further demonstrates that the inclusion of Twitter within a search strategy offers a pragmatic, accessible and low-cost method of increasing the reach and totality of a search.

The results of this scoping review must be considered with respect to its limitations. The inclusion criteria for this review were strict in respect that only CPGs were reviewed, and only those citations that satisfied the definition of a CPG were included. This means that resources that clinicians may use to guide their clinical practice, including those that may be described as a 'guideline' without satisfying the criteria for a CPG, may have been excluded. The focus of this review was also limited to UK practice, which limits the generalisation of the findings; however, it must be considered that the findings are similar to a review of international guidelines (Lin et al., 2019).

4.3 | Comparison with existing literature

The results of this scoping review are similar to the findings of a recent SR of high-quality international CPGs (Lin et al., 2019). This SR aimed to identify recommendations that were common across a wide range of MSK pain conditions, derived from CPGs. With regards to investigations, it was recommended that DI was discouraged unless serious pathology is suspected; there has been unsatisfactory response to conservative care or unexplained progression of signs and symptoms; it is likely to change management. Within this review by Lin et al. (2019), recommendations did not focus on a particular care setting or country of practice and excluded specific disease processes,

for example, rheumatological conditions. The inclusion of regional MSK conditions within this scoping review that may present as LBP, knee or shoulder pain adds to the knowledge base as it highlights a level of consistency with regard to recommendations for the use of DI across clinical populations.

4.4 | Implications for research and practice

This review included 31 CPGs that were published between 2009 and 2019. Twenty-six hits returned by the search were excluded with 18 either due to not fulfilling the definition or criteria of a CPG (n = 12) or being unable to determine whether the definition or criteria had been fulfilled (n = 6). In most circumstances, this related to the absence of an initial SR being undertaken as part of the CPG development process.

The NICE accreditation programme appraises the processes used to develop a CPG with the aim of raising CPG development standards, ensuring high-quality processes are utilised and high-quality information disseminated to clinicians and, in turn, increasing the chances that the guideline is used to improve patient outcomes. The presence of the accreditation award is intended to identify the most trusted sources of CPGs that have been developed (NICE, 2019). Of note was the exclusion of Kulkarni et al. (2015), which had associated NICE accreditation (Kulkarni et al., 2015). The reason for exclusion was because the SR upon which the CPG was supposed to be based had been undertaken in 2009 and was seemingly independent of the CPG process. Therefore, although this means that the publication does not meet the definition of a CPG and is excluded from the review, the wider implication is that the recommendations made may not be based on the most contemporary evidence.

This raises two issues: the first questioning the utility of the NICE accreditation programme as a mark of quality and the second that this publication provides a substantial amount of the information upon which the NICE CKS for shoulder pain (NICE, 2017b) is based, which has been included within this scoping review. In turn, it not clear whether the recommendations made within the CKS are founded on the best available contemporary evidence, which may impact on clinical decisions and subsequent patient outcomes.

The recommendations within the CPGs varied regarding presentation, either by care setting or by level of expertise. Historically, primary care was considered a nonspecialist setting in which an initial assessment would be undertaken and the patient referred to a specialist setting (if needed) in secondary care. In recent years, this approach to patient pathway design has changed with specialist services increasingly delivered in primary and community care settings in the UK, a change further reinforced within the NHS Long Term Plan (NHS England, 2019a). Future CPGs should consider this within the development process to aid implementation of recommendations into contemporary practice.

With the routine use of DI discouraged, it would appear that CPGs do not justify the increasing imaging rates in the UK for MSK pain. This would suggest that other factors such as clinician behaviour or patient expectations may offer a more likely explanation and should be explored through future research.

5 | CONCLUSION

The routine use of DI for those with nontraumatic LBP, knee or shoulder pain is discouraged in primary and intermediate care. DI within a primary care or intermediate care setting within UK practice should be reserved for cases where specific or serious pathology is suspected or where the person is not responding to initial nonsurgical management and the imaging result is expected to change clinical management decisions.

ACKNOWLEDGEMENTS

A. C. was supported by an ACORN PhD Studentship from Keele University and is currently funded through a PhD Studentship from Manchester Metropolitan University. N. E. F. is a National Institute for Health Research (NIHR) Senior Investigator. C. L. is supported by an NIHR Post-Doctoral Fellowship (Dr Chris Littlewood, PDF-2018-11-ST2-005). The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the National Institute for Health Research or the Department of Health and Social Care. There are no conflicts of interest to declare for any of the authors.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Cuff A, Parton S, Tyer R, Dikomitis L, Foster N, Littlewood C. Guidelines for the use of diagnostic imaging in musculoskeletal pain conditions affecting the lower back, knee and shoulder: A scoping review. *Musculoskeletal Care*. 2020;1–10. https://doi.org/10.1002/msc.1497

Appendix 2 - CPG Scoping Review (1) Protocol

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Title

Guidelines for the use of diagnostic imaging in MSK (MSK) pain conditions affecting the shoulder, knee and lower back: a scoping review.

Background

MSK pain conditions are one of the most common reasons for primary care consultation In many situations, there is considerable clinical uncertainty in relation to the diagnosis to which symptoms of pain and reduced function can be attributed. Diagnostic imaging including x-ray, diagnostic ultrasound and magnetic resonance imaging (MRI) are increasingly being requested by primary care clinicians including GPs, nurses and physiotherapists particularly where diagnostic uncertainty exists; Scan results have also been showed to be perceived by patients as authoritative.

For nearly all of those presenting with LBP, knee, or shoulder pain the recommended clinical care is mostly conservative management. Recommended interventions include advice and education, exercise therapy, activity modification, with pharmacological interventions then considered and more invasive treatments such as injection therapy or surgery reserved for a smaller proportion of patients with either clear pathology that indicates a particular type of surgery (e.g. an acute, traumatic rotator cuff tear or a meniscal tear with mechanical signs and symptoms) or for patients whose symptoms persist, are severe and have not responded to previous conservative care.

It has been demonstrated that in the UK, 20% of people with LBP seeking care will receive diagnostic imaging. Whilst more recent data is not available describing the current imaging rates for LBP in the UK, when compared to similarly matched high-income settings such as Norway or the USA, the rates are 38.9% and 53.7% respectively for those seen in primary care. A recent systematic review and meta-analysis investigating the rates of imaging worldwide for LBP between 1995-2015, found that the rate of complex imaging (Computed Tomography (CT) or MRI scan) has increased by 50% for those attending either primary care or the emergency department; 24.8% of patients attending primary care in this time period received diagnostic imaging with this rising to 35.6% of those seen in the emergency department. These figures relate to included primary studies undertaken in North America, Australia, New Zealand, Europe

and the UK; similar figures and higher are seen in low-middle income settings with as many as 100% of patients with persistent LBP undergoing imaging in India in one study and 70% of patients with acute LBP undergoing imaging in Brazil in another study.

Despite the high and increasing use of routine imaging for those presenting with LBP, no significant difference has been reported with regards to pain, function or quality of life between those who receive routine imaging, whether that be x-ray, MRI or CT, when compared to those who do not receive routine imaging for those presenting with acute or sub-acute LBP. Whilst no difference may be seen in relation to clinical outcomes, the problems associated with the overuse of diagnostic imaging are well recognised. A potential waste of finite healthcare resources has a clear economic consequence on a societal level, whilst on a patient level early use of diagnostic imaging and in particular MRI for LBP has the potential to induce fear avoidance beliefs, catastrophisation, poorer perceived prognosis, greater work absenteeism and an increased chance of undergoing spinal surgery. With regard to other imaging modalities, such as x-ray or CT, there is the exposure to unnecessary radiation that has the potential to promote carcinogenesis.

Clinical practice guidelines (CPGs) have been developed to improve the quality of care delivered for those with common MSK conditions and are considered one of the key efforts to improve healthcare. CPGs are defined as ‘statements that include recommendations intended to optimise patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options’.

There is clear uncertainty underpinning the unclear and inconsistent association between imaging findings and symptoms for those with LBP, knee and shoulder pain. When this is combined with the risks associated with the overuse or inappropriate use of diagnostic imaging as well as the potential impact this has on patient outcomes, there is a need to better under the rationale for, and decision making behind the use of diagnostic imaging.

Research Aim

The aim of this scoping review is to identify and map the content of CPGs that are relevant to UK clinical practice in primary and intermediate care with respect to the use of diagnostic imaging for adults with non-traumatic MSK pain conditions affecting the lower back, knee and shoulder.

Objectives

- To identify existing CPGs that inform MSK/Orthopaedic clinical practice in the UK in relation to the use of diagnostic imaging (X-ray, MRI, USS) in those with LBP, knee and shoulder pain.

- To describe and summarise CPGs recommendations on the use of diagnostic imaging in those with LBP, knee and shoulder pain.

- To identify similarities and differences across CPG recommendations.

Methods

Design

A scoping review will be undertaken. A scoping review enables examination and charting of a broad topic area in order to clarify key concepts that inform practice and is thus the most appropriate method to achieve the research aim.

This scoping review was designed with reference to guidance from Peters et al. 2015 (53) and Tricco et al. 2018 (55)

Table1: Inclusion Criteria

The following inclusion criteria will be used to determine which guidelines will be included within this review:

Criterion	Justification
CPGs either developed in the UK or CPGs intended for wider regional use (e.g. continental or international CPGs) that inform MSK/orthopaedic UK clinical practice within primary or intermediate care for adults with non-traumatic LBP, knee and shoulder pain.	This scoping review forms part of a wider research programme and will form the basis of a future qualitative investigation of UK-based clinicians and patients. Given that this qualitative research will be undertaken in the UK and be focused on UK clinical practice, this forms the focus of the review. It is in turn logical to refer to UK-related guidance given different health care systems in different countries. One of the objectives of this review is to identify existing CPGs. A scoping review allows for the mapping and collation of existing evidence whilst identifying gaps and being able to provide future directions. The presence/absence of a development process will be considered within the data charting and subsequent reporting. Intermediate care is defined as services within a care setting that do not require the resources of a general hospital, but deliver a scope beyond that of a traditional primary care service.
CPGs that provide recommendations on the use of diagnostic imaging in adults with non-traumatic LBP, knee and shoulder pain.	The focus of this review is on the shoulder, knee and lower back pain. This focus stems from epidemiological evidence of the prevalence of these MSK pain presentations; they represent the most common body sites for MSK pain in the upper limb, lower limb and spine, respectively. Non-traumatic is defined as pain that is MSK in origin in the absence of a single definable incident of sufficient velocity or force to

	invoke tissue injury such as a fracture or dislocation.
CPGs that are finalised and published within a date limit 2009-2019.	A date limit of the last 10 years was decided with reference to the known literature to ensure that included CPGs are contemporary and therefore appropriate to inform current practice.
CPGs that are: - accessible in the public domain - accessible via publication or internet searches - accessible via recognised professional bodies or societies.	To ensure that it is representative of clinical practice the sources identified need to reflect those that can be accessed readily by clinicians. CPGs that are accessible in the public domain via publication, internet searches or recognised professional bodies/societies are the typical access routes for clinicians and as such both the inclusion criteria and subsequent search strategy reflect this.

Table 2: Exclusion Criteria

Criterion	Justification
CPGs that are not focused on adult populations (less than 18-years).	The focus of this scoping review is adults that present with lower back, knee or shoulder pain.
CPGs or clinical pathways developed by Clinical Commissioning Groups (CCGs) for local implementation.	The focus of this review is CPGs that have been developed and informed following a systematic review of the evidence that are accessible to all clinicians within UK practice.
Indications for the use diagnostic imaging to evaluate the risk of further fragility fractures, including the use of Dual Energy X-ray Assessment (DXA) scanning to determine bone mineral density (BMD).	The focus of this review is on diagnostic imaging for those with lower back, knee or shoulder pain. Whilst indications for assessment of fragility fracture such as major osteoporotic fractures (clinical vertebral and shoulder fractures) are included, the use of DXA within clinical practice is often for the prediction of future fracture in those with clinical risk factors for low BMD, or those that have previously sustained fragility fracture (Ralston et al. 2015).

Search Strategy

A comprehensive search strategy (Tables 3-25) will be used in accordance with recent guidance for conducting a scoping review. An initial search strategy was drafted by the lead author (AC) using key words and search and then refined using the Medical Subject Headings and the National Library of Medicine alongside a health sciences librarian (SP). Search terms were deliberately broad to ensure that the search was comprehensive allowing all relevant guidelines to be identified.

The search terms in tables 3-14 will be combined using Boolean logic and will be used to perform searches of the identified key databases (MEDLINE, CINAHL complete, PsycINFO and SPORTDiscus) from 2009 to the date of search.

Table 3. Search terms to be utilised – Lower Back (Medline)

1. (in title/abstract) MH "Practice Guidelines")
2. (in title/abstract) OR Guideline* OR consensus OR recommendations
3. (title/abstract) AND Lumb* or LBP or NSLBP or CNLSBP or non-specific or low* or back or spin* or radic* or stenosis or facet* or inf* or fracture or scoliosis or cancer* or malign* or cord or cauda or CES or spond* or OA or osteo*
4. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language, Guidelines, Consensus Development Conference, Practice Guideline

Table 4. Search terms to be utilised – Lower Back (CINAHL)

1. (in title/abstract) MH "Practice Guidelines")
2. (in title/abstract) OR Guideline* OR consensus OR recommendations
3. (title/abstract) AND Lumb* or LBP or NSLBP or CNLSBP or non-specific or low* or back or spin* or radic* or stenosis or facet* or inf* or fracture or scoliosis or cancer* or malign* or cord or cauda or CES or spond* or OA or osteo*
4. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language, Practice Guidelines

Table 5. Search terms to be utilised – Lower Back (PsycINFO)

1. (in title/abstract) AND Guideline* OR consensus OR recommendations
2. (title/abstract) AND Lumb* or LBP or NSLBP or CNLSBP or non-specific or low* or back or spin* or radic* or stenosis or facet* or inf* or fracture or scoliosis or cancer* or malign* or cord or cauda or CES or spond* or OA or osteo*
3. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT

Limits: 2009 – to date of search, English Language

Table 6. Search terms to be utilised – Lower Back (SPORTDiscus)

1. (in title/abstract) AND Guideline* OR consensus OR recommendations
2. (title/abstract) AND Lumb* or LBP or NSLBP or CNLSBP or non-specific or low* or back or spin* or radic* or stenosis or facet* or inf* or fracture or scoliosis or cancer* or malign* or cord or cauda or CES or spond* or OA or osteo*
3. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language

Table 7. Search terms to be utilised – Knee (Medline)

1. (in title/abstract) MH “Practice Guidelines”)
2. (in title/abstract) OR Guideline* OR consensus OR recommendations
3. (title/abstract) AND Knee or osteoarthr* or menisc* or ligament* or tend* or musc* or inf* or fracture or cancer* or malign* or osteo* or sarcoma or patell* or PFP
4. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language, Guidelines, Consensus Development Conference, Practice Guideline

Table 8. Search terms to be utilised – Knee (CINAHL)

1. (in title/abstract) MH “Practice Guidelines”)
2. (in title/abstract) OR Guideline* OR consensus OR recommendations
3. (title/abstract) AND Knee or osteoarthr* or menisc* or ligament* or tend* or musc* or inf* or fracture or cancer* or malign* or osteo* or sarcoma or patell* or PFP
4. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language, Practice Guidelines

Table 9. Search terms to be utilised – Knee (PsycINFO)

1. (in title/abstract) AND Guideline* OR consensus OR recommendations

2. (title/abstract) AND Knee or osteoarthr* or menisc* or ligament* or tend* or musc* or inf* or fracture or cancer* or malign* or osteo* or sarcoma or patell* or PFP
3. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language

Table 10. Search terms to be utilised – Knee (SPORTDiscus)

1. (in title/abstract) AND Guideline* OR consensus OR recommendations
2. (title/abstract) AND Knee or osteoarthr* or menisc* or ligament* or tend* or musc* or inf* or fracture or cancer* or malign* or osteo* or sarcoma or patell* or PFP
3. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language

Table 11. Search terms to be utilised – Shoulder (Medline)

1. (in title/abstract) MH “Practice Guidelines”)
2. (in title/abstract) OR Guideline* OR consensus OR recommendations
3. (title/abstract) AND Shoulder or glenohumeral or GHJ or acromioclavicular or ACJ or labr* or SLAP or rotator or cuff or subacromial or impingement or burs* or osteoarthr* or instability or dislocation or unstable or inf* or fracture or cancer* or malign* or osteo* or sarcoma
4. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language, Guidelines, Consensus Development Conference, Practice Guideline

Table 12. Search terms to be utilised – Shoulder (CINAHL)

1. (in title/abstract) MH “Practice Guidelines”)
2. (in title/abstract) OR Guideline* OR consensus OR recommendations
3. (title/abstract) AND Shoulder or glenohumeral or GHJ or acromioclavicular or ACJ or labr* or SLAP or rotator or cuff or subacromial or impingement or burs* or osteoarthr* or instability or dislocation or unstable or inf* or fracture or cancer* or malign* or osteo* or sarcoma
4. (title/abstract) AND

Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language, Practice Guidelines

Table 13. Search terms to be utilised – Shoulder (PsycINFO)

1. (in title/abstract) AND Guideline* OR consensus OR recommendations
2. (title/abstract) AND Shoulder or glenohumeral or GHJ or acromioclavicular or ACJ or labr* or SLAP or rotator or cuff or subacromial or impingement or burs* or osteoarthr* or instability or dislocation or unstable or inf* or fracture or cancer* or malign* or osteo* or sarcoma
3. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language

Table 14. Search terms to be utilised – Shoulder (SPORTDiscus)

1. (in title/abstract) AND Guideline* OR consensus OR recommendations
2. (title/abstract) AND Shoulder or glenohumeral or GHJ or acromioclavicular or ACJ or labr* or SLAP or rotator or cuff or subacromial or impingement or burs* or osteoarthr* or instability or dislocation or unstable or inf* or fracture or cancer* or malign* or osteo* or sarcoma
3. (title/abstract) AND
Imaging or diagnostic imaging or x-ray or radiograp* or ultraso* or USS or MRI or magnetic resonance imaging or computed tomography or radiolog* or CT
Limits: 2009 – to date of search, English Language

A search of guideline repositories will also be conducted to complement the search of scientific databases; the National Institute for Health and Care Excellence (NICE); Guidelines International Network (GIN) and Guidelines (a UK-based repository of clinical guidelines for primary care). The search terms for these repositories are outlined in Tables 15-23.

Table 15: Search terms to be utilised – NICE (Lower Back)

1. Back Pain
2. Limits: Clinical guidelines, Diagnostics guidelines, NICE guidelines, Published

Table 16: Search terms to be utilised – NICE (Knee)

1. Knee Pain
2. Limits: Clinical guidelines, Diagnostics guidelines, NICE guidelines, Published

Table 17: Search terms to be utilised – NICE (Shoulder)

1. Shoulder Pain
2. Limits: Clinical guidelines, Diagnostics guidelines, NICE guidelines, Published

Table 18: Search terms to be utilised – GIN (Lower Back)

1. Low back pain
2. Limits: English, Guideline, Published

Table 19: Search terms to be utilised – GIN (Knee)

1. Knee pain
2. Limits: English, Guideline, Published

Table 20: Search terms to be utilised – GIN (Shoulder)

1. Shoulder pain
2. Limits: English, Guideline, Published

Table 21: Search terms to be utilised – Guidelines (Lower Back)

1. Low back pain
2. Filters: MSK and joints, 2009 – to date of search

Table 22: Search terms to be utilised – Guidelines (Knee)

1. Knee pain
2. Filters: MSK and joints, 2009 – to date of search

Table 23: Search terms to be utilised – Guidelines (Shoulder)

1. Shoulder pain
2. Filters: MSK and joints, 2009 – to date of search

Alongside the systematic search detailed above, a 'snowball' search will also be performed to identify any published CPGs that meet the inclusion criteria that may have been missed by the search of scientific databases and guideline repositories.

In the snowball search, the terms described in table 24 will be entered into a Google search and the top 50 results will be assessed (Lowe et al. 2016). To complete the 'snowball' search the websites of the following professional bodies that are relevant to primary care MSK clinical practice will be searched: Royal College of General Practitioners (RCGP), The Royal College of Radiologists (RCR), Chartered Society of Physiotherapy (CSP), Primary Care Rheumatology Society (PCR) and the British Association of Sport and Exercise Medicine (BASEM).

Table 24: Snowball search terms

Knee Pain Guidelines
Shoulder Pain Guidelines

Low Back Pain Guidelines

A request for CPGs that meet the inclusion criteria will be circulated through the following clinical networks: Advanced Practice Physiotherapy Network (APPN); RCGP; RCR; CSP; PCR; BASEM.

A message (Table 25) will be distributed on Twitter and promoted for 14 days; responses to the message will be reviewed by the lead author (AC) for relevance.

Table 25: Twitter message

Please help with my PhD research by sharing any clinical practice guidelines that indicate when to order #diagnostic #imaging for #knee, #shoulder or #LBP. Retweets appreciated. Thank you.

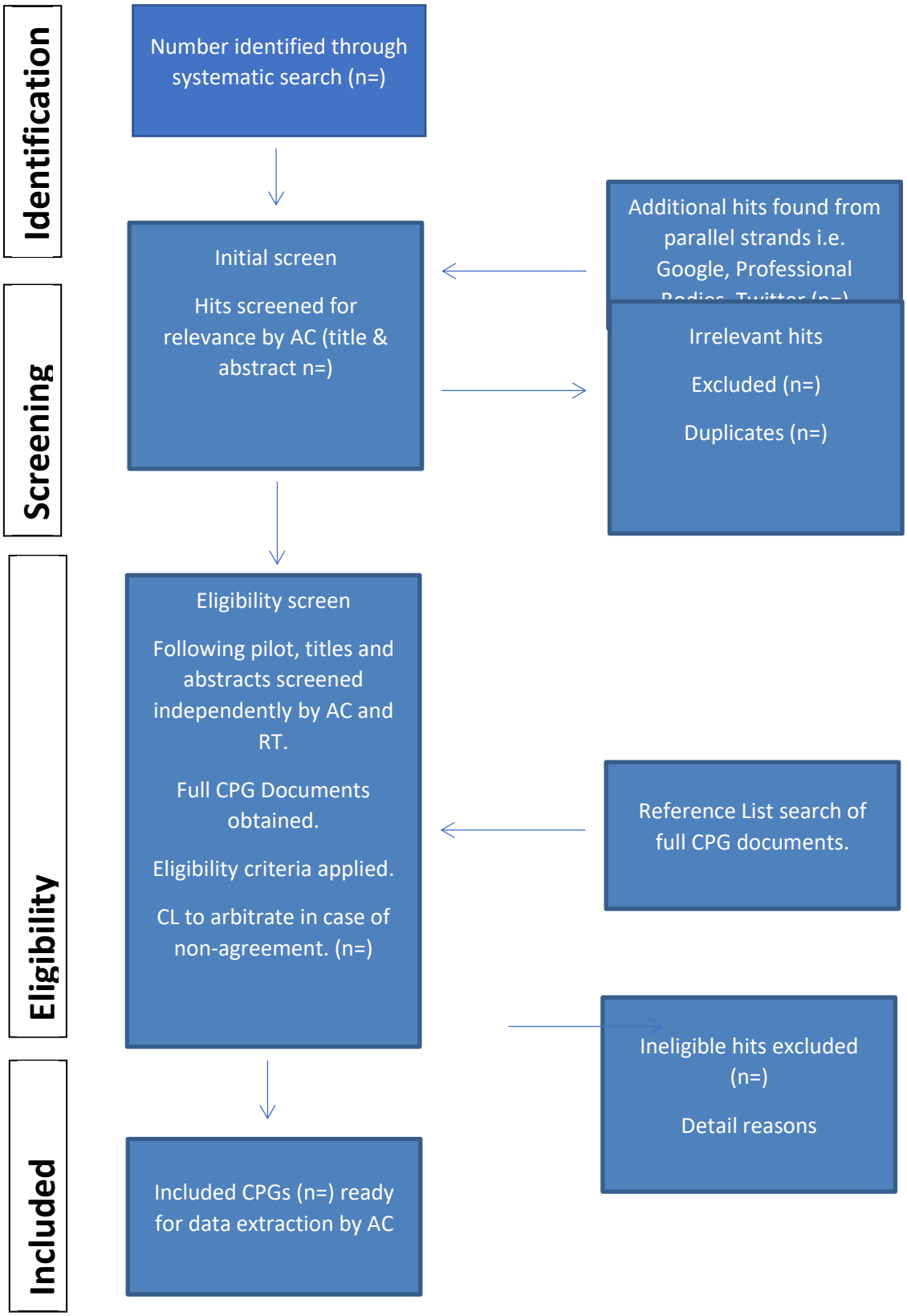
The lead author (AC) will read all titles identified by the search and duplicates will be removed using Mendeley reference management software; any obviously irrelevant hits were removed by AC at this stage. AC and RT with independently conduct a pilot evaluation of the inclusion and exclusion criteria on ten of the remaining hits and modifications will be made as necessary if disagreement is apparent or there is difficulty applying the criteria; a third member of the review team will arbitrate (CL) in the event of disagreement.

If abstracts are available, they will be reviewed independently by two authors (AC and RT) who will apply the inclusion/exclusion criteria; a third member of the review team will arbitrate (CL) in the event of disagreement. Where a decision cannot be made on eligibility from the abstract, or if an abstract for the CPG is not available, the full CPG document will be obtained. Conference abstracts or summaries of CPGs presented within conference listings will not be excluded initially. If such abstracts/summaries are identified within the search, attempts will be made and documented to obtain a full copy of the CPG. If a full copy of the CPG cannot be obtained, then it will be excluded.

Full CPG documents will be reviewed independently by two authors (AC and RT) who will apply the inclusion/exclusion criteria; a third member of the review team will arbitrate (CL) in the event of disagreement. A systematic review process must be outlined to meet the definition of a CPG; if it is not clear whether a systematic review has been undertaken as part of the guideline development process then the producing organisation (or authors if there is no producing organisation) will be contacted for further information. If a systematic review has not been undertaken or there is no response received to the request for further information, then the document will be excluded as it does not meet the definition of a CPG.

To complete the search strategy, the reference list of all CPGs where a full CPG document has been obtained will be hand searched.

Figure 1. Flowchart of the CPG Selection Process



Quality Appraisal

CPGs that have been developed without a documented and transparent development process will be included in the review as one of the objectives is to identify all relevant existing CPGs. A scoping review allows for the mapping and collation of existing evidence whilst identifying gaps and being able to inform future directions. The presence/absence of a development process will be considered within the data charting and subsequent reporting.

Formal appraisal of methodological quality is generally not performed in scoping reviews and is regarded as optional. Given the overarching aim of this review is to identify and map the content of CPGs that are relevant to UK clinical practice with respect to the use of diagnostic imaging, rather than the full CPG, for those with LBP, knee and shoulder pain, a full assessment of methodological quality is not necessary. To provide context to the reporting, an assessment of the rigour of the development process will be performed through a modification of the Appraisal of Guidelines for Research and Evaluation (AGREE) II tool. The AGREE II tool has been demonstrated to be a valid and reliable appraisal instrument for clinical practice guidelines and is the most commonly utilised tool for this purpose.

All included CPGs will be appraised using the third domain of the AGREE II tool 'Rigour of Development'; the AGREE II tool does not provide cut off scores for whether a CPG is high or low quality however, previous reviews have utilised this domain as an important indicator of CPG quality. If a CPG scores equal to, or higher than 50% then the CPG will be deemed high quality (Lin et al. 2017).

Each CPG will be appraised by AC and verified by RT; to ensure familiarity with the tool, both AC and RT will complete the two training exercises available via the AGREE II website. A third member of the review team will arbitrate (CL) in the event of disagreement.

Charting the results (Data Extraction)

The relevant characteristics of the included CPGs and the key data relevant to the review aims and objectives will be recorded in a charting table (Table 26).

Data extraction will be independently trialled by AC and RT on five included CPGs to assess the suitability and capacity to chart all relevant information required to answer the research questions. If changes are deemed to be required, these will be agreed upon by AC and RT (CL will arbitrate in the event of any disagreement) and implemented. AC and RT will be the reviewers responsible for charting the results.

Table 26. Charting Table

Authors	Year	Development Group e.g. NICE, RCR	Development Process	Origin	Agree II Score (%)	Clinical Condition e.g. GHJ OA	Care Setting e.g. Primary/Secondary Care	Concept e.g. Imaging Modality	Key Findings that relate to the review questions (Inc. recommendations for/against diagnostic imaging and under what circumstances)

Presentation of the results (Synthesis and Reporting)

The content of the included CPGs will determine how they are presented. It is anticipated that they will be presented with reference to their development process, content and recommendation presented in a tabular form, as outlined in Table 26. An associated descriptive narrative that aligns the results to the aims of the review will also be presented, in particular exploring areas of agreement and discrepancy across the CPG recommendations and body regions.

Dissemination

The finalised manuscript of the scoping review will be written up for publication and submitted for presentation at relevant national and international conferences.

In addition to formal publication, findings of the scoping review will be disseminated through social media in the form of an infographic.

These findings from the review will be utilised to inform the development of topic guides for use within future qualitative studies. These qualitative studies will form the second phase of the PhD and consist of interviews with clinicians involved in the requesting of diagnostic imaging, and patients seeking care with LBP, knee and shoulder pain. The aim of these qualitative studies is to gain insight and understanding behind the rationale and decision making for diagnostic imaging.

Project Gantt Chart

Activity	April	May	June	July
Finalise Protocol				
Run Search, Select Studies, Data Extraction				
Data Analysis				
Write Manuscript				
Submission & dissemination				

Appendix 3 - A data charting table of recommendations from Clinical Practice Guidelines that inform MSK/Orthopaedic clinical practice in the UK on the use of diagnostic imaging in those with Low Back Pain (LBP).

Authors	Year	Development Group e.g. NICE, RCR	Origin	Agree II Score (%)	Clinical Condition e.g. GHJ OA	Key Findings that relate to the review questions (Inc. recommendations for/against diagnostic imaging and under what circumstances)
Ward et al.	2016	National Institute for Health and Care Excellence (NICE)	UK	91%	LBP and Sciatica	Do not routinely offer imaging in a non-specialist setting for people with low back pain with or without sciatica. Explain to people with low back pain with or without sciatica that if they are being referred for specialist opinion, they may not need imaging. Consider imaging in specialist settings of care (for example, a MSK interface clinic or hospital) for people with low back pain with or without sciatica only if the result is likely to change management.
NICE Clinical Knowledge Summary (CKS)	2018	NICE	UK	50%	LBP	Do not routinely X-ray the spine to diagnose non-specific low back pain, as it will generally not inform management. • However, spinal X-ray may be indicated if there is suspicion of a specific pathology, such as a compression fracture due to osteoporosis. If there are Red flag symptoms and signs that may suggest a serious underlying cause, admit or refer urgently for specialist assessment, or imaging, using clinical judgement.
NICE CKS	2018	NICE	UK	50%	Sciatica	**Do not routinely X-ray the spine to confirm the diagnosis.**
NICE CKS	2013	NICE	UK	51.7%	Ankylosing Spondylitis (AS)	Follow local referral protocols on imaging the sacroiliac joints and spine or seek specialist advice on imaging before referral. AS is suggested by X-ray changes of the sacroiliac joints and spine, including sacroiliitis, sclerosis (thickening of bone), erosions, and partial or total ankylosis (fusion of joints). Magnetic resonance imaging (MRI). In some people with symptoms of AS inflammation of the sacroiliac joints can be detected on MRI despite an absence of changes on X-ray. The use of MRI has enabled an increase in detection of sacroiliitis and inflammatory back pain and the diagnosis of non-radiographic axial spondyloarthritis.
White et al.	2014	NICE	UK	78.6%	Metastatic Spinal Cord Compression (MSCC)	Do not perform plain radiographs of the spine either to make or to exclude the diagnosis of spinal metastases or MSCC. MRI of the spine in patients with suspected MSCC should be supervised and reported by a radiologist and should include sagittal T1 and/or short T1 inversion recovery (STIR) sequences of the whole spine, to prove or

						exclude the presence of spinal metastases. Sagittal T2 weighted sequences should also be performed to show the level and degree of compression of the cord or cauda equina by a soft tissue mass and to detect lesions within the cord itself. Supplementary axial imaging should be performed through any significant abnormality noted on the sagittal scan. Contact the MSCC coordinator to determine the most appropriate method of imaging for patients with suspected MSCC in whom MRI is contraindicated and where this should be carried out. In patients with a previous diagnosis of malignancy, routine imaging of the spine is not recommended if they are asymptomatic. Serial imaging of the spine in asymptomatic patients with cancer who are at high risk of developing spinal metastases should only be performed as part of a randomised controlled trial. Perform MRI of the whole spine in patients with suspected MSCC, unless there is a specific contraindication. This should be done in time to allow definitive treatment to be planned within 1 week of the suspected diagnosis in the case of spinal pain suggestive of spinal metastases, and within 24 hours in the case of spinal pain suggestive of spinal metastases and neurological symptoms or signs suggestive of MSCC, and occasionally sooner if there is a pressing clinical need for emergency surgery.

Appendix 4 – A data charting table of recommendations from Clinical Practice Guidelines that inform MSK/Orthopaedic clinical practice in the UK on the use of diagnostic imaging in those with Knee Pain.

Authors	Year	Development Group e.g. NICE, RCR	Origin	Agree II Score (%)	Clinical Condition e.g. GHJ OA	Key Findings that relate to the review questions (Inc. recommendations for/against diagnostic imaging and under what circumstances)
Zhang et al.	2010	EULAR	Europe	57.1%	Knee OA	Knee OA is characterised clinically by usage-related pain and/or functional limitation. It is a common complex joint disorder showing focal cartilage loss, new bone formation and involvement of all joint tissues. Structural tissue changes are mirrored in classical radiographic features. In adults aged >40 years with usage-related knee pain, only short-lived morning stiffness, functional limitation and one or more typical examination findings (crepitus, restricted movement, bony enlargement), a confident diagnosis of knee OA can be made without a radiographic examination. This applies even if radiographs appear normal. Plain radiography (both knees, weightbearing, semiflexed PA (MTP) view, plus a lateral and skyline view) is the current 'gold standard' for morphological assessment of knee OA. Classical features are focal joint space narrowing, osteophyte, subchondral bone sclerosis and subchondral cysts. Further imaging modalities (MRI, sonography, scintigraphy) are seldom indicated for diagnosis of OA.
Price et al.	2017	British Orthopaedic Association (BOA)	UK	26.7%	Knee OA	A clinical diagnosis of Osteoarthritis can be made by focusing on the following six clinical symptoms and signs: persistent knee pain, limited knee stiffness (<30 minutes), reduced function, crepitus, restricted movement and bony enlargement. Plain radiographs may be taken for initial diagnosis but are not essential in patients over 45.
Sakellariou et al.	2017	EULAR	Europe	64.2	Peripheral Joint OA – knee	Imaging is not required to make the diagnosis in patients with typical (usage-related pain, short duration morning stiffness, age >40, symptoms affecting one or a few joints) presentation of OA. In atypical presentations, imaging is recommended to help confirm the diagnosis of OA and/or make alternative or additional diagnoses. Routine imaging in OA follow-up is not recommended. However, imaging is recommended if there is unexpected rapid progression of symptoms or change in clinical characteristics to determine if this relates to OA severity or an additional diagnosis. If imaging is needed, conventional (plain) radiography should be used before other modalities. To make additional diagnoses, soft tissues are best imaged by US or MRI and bone by CT or MRI. Consideration of radiographic views is important for optimising detection of OA features; in particular for the knee, weightbearing and patellofemoral views are recommended. According to current evidence, imaging features do not predict non-surgical treatment response and imaging cannot be recommended for this purpose.
Fernandes et al.	2017	EULAR	Europe	57.1%	OA	Whilst a comprehensive initial assessment is considered to be a prerequisite for an individualised management strategy, no recommendations for the use of imaging within the diagnosis or core non-pharmacological management of knee OA.

Crossley et al.	2016	Patellofemoral Pain Research Retreat	International	53.5%	PFP	No recommendations for the use of imaging within the diagnosis or management of PFP.
Barton et al.	2015	N/A	International	57.1%	PFP	No recommendations for the use of imaging within the diagnosis or management of PFP.
McAlindon et al.	2014	Osteoarthritis Research Society International (OARSI)	International	60.7%	Knee OA	No recommendations for the use of imaging within the non-surgical management of knee OA.
NICE CKS	2017	NICE	UK	48.2%	Knee	No recommendations for the use of imaging within the diagnosis or management of non-traumatic knee pain.

Appendix 5

A data charting table of recommendations from Clinical Practice Guidelines that inform MSK/Orthopaedic clinical practice in the UK on the use of diagnostic imaging in those with regional conditions that may present as Low Back Pain, Knee or Shoulder Pain.

Authors	Year	Development Group e.g. NICE, RCR	Origin	Agree II Score (%)	Clinical Condition e.g. GHJ OA	Key Findings that relate to the review questions (Inc. recommendations for/against diagnostic imaging and under what circumstances)
Osteoporosis						
Compston et al.	2017	National Osteoporosis Guideline Group	UK	62.5%	Osteoporosis (Major osteoporotic fractures – clinical vertebral or proximal humerus fracture).	Vertebral fracture assessment should be considered in postmenopausal women and older men if there is a history of ≥4cm height loss, kyphosis, recent or current long-term oral glucocorticoid therapy, or a BMD T-score ≤-2.5. It should also be considered in individuals with a history of non-vertebral fracture after the age of 50 years. Vertebral fracture assessment should therefore be considered in high risk individuals, using either lateral lumbar and thoracic spine radiographs or lateral spine DXA imaging. The latter delivers a significantly lower radiation dose but performs comparably to traditional radiographs. No recommendations provided for the use of imaging within the diagnosis or management of proximal humerus fracture.
Ralston et al.	2015	Scottish International Guidelines Network (SIGN)	UK	66%	Osteoporosis (Major osteoporotic fractures – clinical spine	No recommendations provided for the use of imaging within the diagnosis or management of those with clinical vertebral or proximal humerus fracture.

					or proximal humerus fracture).	
Lems et al.	2016	EULAR	Europe	50%	Fragility fracture – clinical spine or proximal humerus fracture.	No recommendations provided for the use of imaging within the diagnosis or management of those with clinical vertebral or proximal humerus fracture.
Spondyloarthropathy						
McVeigh et al.	2017	NICE	UK	80%	SpA	No recommendations for the use of imaging within the diagnosis or management of SpA in non-specialist settings (primary care). Diagnosing spondyloarthritis in specialist care settings (which may include intermediate care): Imaging for suspected axial spondyloarthritis Initial investigation using X-ray Offer plain film X-ray of the sacroiliac joints for people with suspected axial spondyloarthritis, unless the person is likely to have an immature skeleton. Diagnose radiographic axial spondyloarthritis (ankylosing spondylitis) if the plain film X-ray shows sacroiliitis meeting the modified New York criteria (bilateral grade 2–4 or unilateral grade 3–4 sacroiliitis). If the plain film X-ray does not show sacroiliitis meeting modified New York criteria (bilateral grade 2–4 or unilateral grade 3–4 sacroiliitis), or an X-ray is not appropriate because the person's skeleton is not fully mature, request unenhanced MRI using an inflammatory back pain protocol.

						Subsequent investigation using MRI Radiologists receiving a request for an inflammatory back pain MRI should perform short T1 inversion recovery (STIR) and T1 weighted sequences of the whole spine (sagittal view), and sacroiliac joints (coronal oblique view). Use the ASAS/Outcome Measures in Rheumatology (OMERACT) MRI criteria to interpret the MRI as follows: • If the MRI meets the ASAS/OMERACT MRI criteria: o diagnose non-radiographic axial spondyloarthritis. • If the MRI does not meet the ASAS/OMERACT MRI criteria: o do not exclude the possibility of axial spondyloarthritis o consider specialist MSK radiology review if there is disparity between the clinical suspicion and imaging findings, particularly in people with an immature skeleton o offer an HLA-B27 test if it has not already been done. If positive, base the diagnosis of non-radiographic axial spondyloarthritis on clinical features, for example, using the clinical 'arm' of the ASAS axial classification criteria.

						If a diagnosis of axial spondyloarthritis cannot be confirmed and clinical suspicion remains high, consider a follow-up MRI. Other types of imaging for diagnosing axial spondyloarthritis Do not offer scintigraphy for people with suspected axial spondyloarthritis. Imaging for suspected psoriatic arthritis and other peripheral spondyloarthritides Offer plain film X-ray of symptomatic hands and feet for people with suspected peripheral spondyloarthritis in these areas. If a diagnosis cannot be made from the plain film X-ray, consider ultrasound of: • the hands and feet to assess for joint involvement • suspected enthesitis sites. Consider plain film X-rays, ultrasound and/or MRI of other peripheral and axial symptomatic sites. If a diagnosis of peripheral spondyloarthritis is confirmed, offer plain film X-ray of the sacroiliac joints to assess for axial involvement, even if the person does not have any symptoms.
Mandl et al.	2015	EULAR	Europe	41%	SpA	Axial SpA: diagnosis A. In general, conventional radiography of the SI joints is recommended as the first imaging method to diagnose sacroiliitis as part of axial SpA. In certain

						cases, such as young patients and those with short symptom duration, MRI of the SI joints is an alternative first imaging method. B. If the diagnosis of axial SpA cannot be established based on clinical features and conventional radiography, and axial SpA is still suspected, MRI of the SI joints is recommended. On MRI, both active inflammatory lesions (primarily bone marrow oedema) and structural lesions (such as bone erosion, new bone formation, sclerosis and fat infiltration) should be considered. MRI of the spine is not generally recommended to diagnose axial SpA. C. Imaging modalities, other than conventional radiography and MRI are generally not recommended in the diagnosis of axial SpA. CT may provide additional information on structural damage if conventional radiography is negative and MRI cannot be performed. Scintigraphy and US are not recommended for diagnosis of sacroiliitis as part of axial SpA. Peripheral SpA: diagnosis When peripheral SpA is suspected, US or MRI may be used to detect peripheral enthesitis, which may support the diagnosis of SpA. Furthermore, US or MRI might be used to detect peripheral arthritis, tenosynovitis and bursitis. Spinal fracture When spinal fracture in (someone with known) axial

						SpA is suspected, conventional radiography is the recommended initial imaging method. If conventional radiography is negative, CT should be performed. MRI is an additional imaging method to CT, which can also provide information on soft tissue lesions. Recommendations related to monitoring activity, monitoring structural changes, predicting outcome/severity/treatment effect have not been extracted as these are unlikely to take place within primary/intermediate care.
Osteoarthritis (OA)						
NICE CKS	2018	NICE	UK	51.7%	OA - any synovial joint, with knee being a focus alongside hip/hand.	Routine X-ray of the affected joint(s) is not usually needed to confirm the diagnosis. Consider arranging an X-ray, depending on clinical judgement: • If there is diagnostic uncertainty. • To exclude alternative conditions. • If there is a sudden clinical deterioration in symptoms. o Typical radiological features of osteoarthritis include subchondral bone thickening and/or cysts; osteophyte formation (new bone formation at joint margins); loss or narrowing of the joint space (provides an estimate of the severity of cartilage damage). • Note: structural changes on X-ray may not correlate with reported symptoms and functional impairment.
Conaghan et al.	2014	NICE	UK	83.9%	OA	Diagnose osteoarthritis clinically without investigations if a person: - is 45 or over and - has activity-related joint pain and

						- has either no morning joint-related stiffness or morning stiffness that lasts no longer than 30minutes.
Rheumatoid Arthritis (RA)						
Ward et al.	2018	NICE	UK	89.2%	RA	No recommendations for the use of imaging within the diagnosis or management of RA with reference to those presenting with LBP, knee or shoulder pain. X-ray the hands and feet in adults with suspected RA and persistent synovitis (in these joints). Do not use ultrasound for routine monitoring of disease activity in adults with RA.
Colebatch et al.	2013	EULAR	Europe	57.1%	RA	**When there is diagnostic doubt, x-ray, ultrasound or MRI can be used to improve the certainty of a diagnosis of RA above clinical criteria alone. *Knee and Shoulder*** The presence of inflammation seen with ultrasound or MRI can be used to predict the progression to clinical RA from undifferentiated inflammatory arthritis. *Knee* **Ultrasound and MRI are superior to clinical examination in the detection of joint inflammation; these techniques should be considered for a more accurate assessment of inflammation. *Knee***
Gout						
Richette et al.	2016	EULAR	Europe	55.3%	Gout - Management	No recommendations for the use of imaging within the diagnosis or management of Gout.
Richette et al.	2018	EULAR	Europe	50%	Gout - Diagnosis	When a clinical diagnosis of gout is uncertain and crystal identification is not possible, patients should be investigated by imaging to search for MSU crystal deposition and features of any alternative diagnosis.

						Plain radiographs are indicated to search for imaging evidence of MSU crystal deposition but have limited value for the diagnosis of gout flare. USS can be more helpful in established a diagnosis in patients with suspected gout flare or chronic gouty arthritis by detection of tophi not evident on clinical examination, or a double contour sign at cartilage surfaces, which is highly specific for urate deposits in joints. …continuum from preclinical states (asymptomatic hyperuricaemia and then asymptomatic MSU crystal deposition) to gout (clinical states). The EULAR recommends a three-step approach for the diagnosis of gout. *The first step relies on MSU crystal identification in synovial fluid or tophus aspirates; **If not feasible, the second step relies on a clinical diagnosis (based on the presence of hyperuricaemia and associated clinical features of gout); ***The last step recommends imaging, particularly USS or DECT, to search for imaging evidence of MSU crystal deposition when a clinical diagnosis of gout is uncertain and crystal identification is not possible.
Hui et al.	2017	BSR	UK	53.5%	Gout	No recommendations for the use of imaging within the diagnosis or management of Gout.
Malignancy						
Hajioff et al.	2015	NICE	UK	94.6%	Suspected Cancer	Consider an urgent direct access ultrasound scan (to be performed within 2 weeks) to assess for soft tissue sarcoma in adults with an unexplained lump that is increasing in size. Consider a very urgent direct access ultrasound scan (to be performed within 48hours) to assess for soft tissue sarcoma in children and young people (up to 24 years) with an unexplained lump that is increasing in size.

						Bone pain or swelling (unexplained) in children and young people (up to 24 years), Consider a very urgent direct access X-ray (to be performed within 48 hours).
Paget's Disease						
Ralston et al.	2019	Paget's Association UK	UK		Paget's Disease	Plain X-rays of the abdomen, tibias, skull, and facial bones are recommended as an initial diagnostic screening test in patients suspected to have Paget's Disease on a biochemical (raised serum total alkaline phosphatase (ALP) with normal liver function test) or clinical grounds. In those presenting with 'bone pain', bone deformity or pathological fracture a targeted X-ray of the site is recommended. MRI is not recommended for the diagnosis of Paget's disease but is recommended to assess disease complications e.g. spinal stenosis.
Miscellaneous						
Remedios	2017	The Royal College of Radiologists (RCR)	UK	64.2%	Imaging for Primary Care for all common MSK conditions.	Painful shoulder (including impingement syndrome and rotator cuff tear) Specialised investigation [B] US is the investigation of choice in the assessment of rotator cuff and surrounding soft tissues. It may be used to guide injection. It is reserved for cases unresponsive to firstline treatment and clinically guided injection. It is indicated preoperatively if the surgeon requires assessment of rotator cuff integrity. Specialised investigation [B]

						MRI is an alternative to US and is useful after major trauma to assess complex injury and bony abnormality. MRI can show alternative pathology when other modalities are unrevealing. Indicated only in specific circumstances [C] XR is used as a preoperative assessment. Impingement is clinically diagnosed. XR is indicated for persistent shoulder pain that is unresponsive to conservative treatment to exclude calcific tendinitis and diagnoses unrelated to the rotator cuff. Knee pain without trauma, locking or restriction in movement USS - Indicated only in specific circumstances [C] MRI - Indicated only in specific circumstances [B] XR – Specialised investigation [C] Clinical features will often be sufficient to guide management without the need for imaging. Red flags to guide referral include: • Acute swelling (<24 hours) • Mono-arthritis • Severe pain out of proportion to the usual symptoms • Fever • Risk factors for infection: recent surgery, rheumatoid arthritis, immunocompromised, adjacent skin infection • Rest pain or morning stiffness • Joint swelling, tenderness and warmth.

						Symptoms frequently arise from soft tissues, which will not show on XR. Osteoarthritic changes are common in those aged 45-plus. XR may help when there is uncertainty of diagnosis. MRI is useful in patients with persistent undiagnosed pain, including suspected avascular necrosis, cartilage pathology and sepsis. US in expert hands is useful for anterior knee pain with suspected tendinopathy or associated bursitis. Knee pain with locking USS – not indicated. MRI - MRI is the investigation of choice to identify meniscal tears and loose bodies. Indicated [B] XR - XR will identify radio-opaque loose bodies – a less frequent cause of locking. Indicated [C]) Chronic lumbar back pain (>6 weeks) with no clinical or serological indicators of infection or neoplasia (i.e. no red flags) USS – not indicated MRI - MRI is the preferred investigation for the diagnosis of most spinal diseases and is helpful in identifying those patients who may benefit when planning surgical intervention or pain management. Indicated only in specific circumstances [C]

						XR - XR is only indicated if presentation suggests osteoporotic collapse in the elderly. Indicated only in specific circumstances [C] Acute back pain (≤6 weeks) without potentially serious features (malignancy, infection, fracture, CES, AS or another inflammatory disorder) USS – not indicated MRI - For patients with non-specific back pain (with no radicular symptoms or red flags), MRI does not help clinical outcome. It should be reserved for patients referred for orthopaedic opinion. MRI is the preferred investigation (wider field of view visualising the conus, postoperative changes, etc). Indicated only in specific circumstances [C] XR – Acute back pain is usually the results of conditions that cannot be diagnosed on XR (osteoporotic collapse is an exception). Normal XR may be falsely reassuring. Indicated only in specific circumstances [C]. Acute back pain (≤6 weeks) with potentially serious features (CES, previous malignancy, immunosuppression, steroid use, fever) USS – not indicated MRI – is the imaging investigation of choice. It is indicated immediately in patients with acute neurological features and urgently in those with suspected malignancy or infection. Indicated [B].

						XR – Plain radiograph may be required preoperatively. MRI is preferable as the first line investigation in patients with potentially serious features, since it has a stronger negative predictive value. Indicated only in specific circumstances [C]. Suspected Osteomyelitis USS – not indicated in adults MRI - MRI accurately shows osteomyelitis and associated soft tissue abnormality. It is the best imaging technique in suspected osteomyelitis. Indicated [B]. XR - XR is the initial investigation but may be normal in early osteomyelitis. Indicated [C]. Suspected primary bone tumour USS – not indicated in primary/intermediate care. Indicated only in specific circumstances [B] MRI – not indicated in primary/intermediate care. Indicated [B] XR – should be used in cases of unresolving bone pain. Indicated [B] Soft tissue mass (stable, soft, mobile, non-tender lumps <5cm do not routinely warrant imaging) USS – is the first investigation for soft tissue masses, is usually sufficient for superficial lesions and can provide specific diagnosis in some cases. It

						can differentiate solid and cystic lesions and also assess the internal vascularity. US is also useful to monitor benign masses (e.g. haematomas) and to assess for local recurrence of soft tissue sarcomas. Indicated [B] MRI – indicated for assessment of deep seated and larger lesions. MRI may be helpful for indeterminate soft tissue masses. Indicated [B] XR – only useful if lesions is close to bone or for assessment of internal calcification. Indicated [B] Bone pain USS – may be helpful to assess suspected infection, tumour and some fractures (particularly in children). US may also help guide biopsy. Indicated only in specific circumstances [C] MRI – is appropriate if pain persisted with a normal XR. MRI may also provide further information when XR and/or NM findings are abnormal. Indicated [C] XR – gives a dedicated view of the symptomatic area. Indicated [C] Metabolic bone disease USS – not indicated MRI – may distinguish acute from chronic osteoporotic collapse. It also distinguishes between osteoporotic and malignant vertebral collapse. Indicated only in specific circumstances [B]

						XR – is helpful in the identification of osteoporotic collapse and differentiation from other unrelated causes. It also identifies characteristic signs of other metabolic bone disease, including osteomalacia and hyperparathyroidism. It is important in correlation with NM abnormalities. Indicated [C] Suspected osteoporotic collapse USS – not indicated MRI – distinguishes acute from chronic osteoporotic collapse and may determine between osteoporotic and malignant vertebral collapse. PET-CT is an alternative to MRI to differentiate malignant from benign fractures. Specialised investigation [C] XR – Lateral XR of the thoracic and lumbar spine is the fist investigation in suspected osteoporotic collapse. In the elderly, fracture on XR is adequate to establish a diagnosis and DEXA is unnecessary unless monitoring of treatment is required. Indicated [B] Arthropathy USS – can show acute synovitis and erosions allowing early introduction of disease-modifying drugs. Maybe helpful both for assessment and monitoring of activity. Specialised investigation [B] MRI - can show acute synovitis and erosions allowing early introduction of disease-modifying drugs; bone marrow oedema is a strong predictor of radiographic progression. Specialised investigation [B]

						XR – of the affected joint (shoulder, knee) may be helpful to establish cause, although erosions are a relatively late feature.

Appendix 6

A data charting table of recommendations from Clinical Practice Guidelines that inform MSK/Orthopaedic clinical practice in the UK on the use of diagnostic imaging in those with Shoulder pain.

Authors	Year	Development Group e.g. NICE, RCR	Origin	Agree II Score (%)	Clinical Condition e.g. GHJ OA	Key Findings that relate to the review questions (Inc. recommendations for/against diagnostic imaging and under what circumstances)
Hanchard et al.	2011	Chartered Society of Physiotherapy (CSP)	Frozen Shoulder	71.4%	Frozen Shoulder	A normal X-ray is prerequisite to a definitive diagnosis of contracted (frozen) shoulder. Restricted passive external rotation and the capsular pattern are not unique to contracted (frozen) shoulder: locked dislocations restrict passive external rotation, and arthritis and joint fractures cause a capsular pattern. All are visible on X-ray, though orthogonal views (views taken at right angles) are recommended in order that abnormalities are not overlooked. It is perhaps unrealistic to expect that all patients presenting with the clinical features of contracted (frozen) shoulder will routinely be referred for X-ray, but it should be remembered that in the absence of this procedure the diagnosis is tentative. Care should therefore be taken during the history to rule out substantial trauma, systemic (body-wide) disease and general ill-health; specific examination should be made for crepitus (gross creaking or grating) on passive movement; and a poor response to treatment should promptly trigger further investigation.

Dejaco et al.	2015	EULAR	Europe	75%	Polymyalgia Rheumatica (PMR)	No recommendations for the use of imaging within the diagnosis or management of PMR.
NICE CKS	2017	NICE	UK	46.4%	Shoulder	Perform investigations, if appropriate. Investigations should be guided by the suspected cause. (Blood tests and radiography are not usually indicated as part of a primary care assessment of shoulder pain). • Consider anteroposterior and lateral shoulders X-rays if: o There is a history of trauma. o The person is not improving with conservative treatment or symptoms are lasting more than four weeks. o Movement is significantly restricted. o There is severe pain. o Any red flags are present. o Arthritis is suspected. • Ultrasound or MRI should not usually be requested by primary care.

Appendix 7 - Excluded articles with reasons for CPG Scoping Reviews

The table below outlines the detailed reasons for exclusion of each hit that was excluded at full document stage within the scoping review of clinical practice guidelines (CPG).

Lead Author/Development Group	Year	Title	Reason for exclusion
National Osteoporosis Society	2017	Clinical guidance for the effective identification of vertebral fractures.	It was not clear whether a systematic review had been conducted as part of the CPG development process (in order to meet the definition of a CPG). Authors were contacted in June 2019 for further information with no reply received.
Balague	2012	Non-specific low back pain	Did not fulfil the criteria of a CPG – a seminar paper within Lancet.
Barry	2012	Osteoporosis: fragility fracture risk	Whilst a CPG, the focus of this CPG was on the prediction/prevention of future fragility fractures rather than assessment/diagnosis of the person presenting with lower back, knee or shoulder pain.
Conaghan	2011	Summary and recommendations of the OARSI FDA osteoarthritis Assessment of Structural Change Working Group	Did not fulfil the criteria of a CPG – a paper providing guidance to research groups on imaging tools for OA clinical trials.
Crossley	2016	2016 Patellofemoral pain consensus statement from the 4th International Patellofemoral Pain Research Retreat, Manchester. Part 1: Terminology, definitions, clinical examination, natural history, patellofemoral osteoarthritis and patient-reported outcome measure	Did not fulfil the criteria of a CPG as the paper was a consensus statement from a research retreat.
Diercks	2014	Guideline for diagnosis and treatment of subacromial pain syndrome A multidisciplinary review by the Dutch Orthopaedic Association	CPG developed for intended use in the Netherlands only.

Gerrand	2016	UK guidelines for the management of bone sarcomas	It was not clear whether a systematic review had been conducted as part of the CPG development process (in order to meet the definition of a CPG). Authors were contacted in June 2019 for further information with no reply received.
Greenough	2017	National Low Back and Radicular Pain Pathway	It was not clear whether a systematic review had been conducted as part of the CPG development process (in order to meet the definition of a CPG). Authors were contacted in June 2019 for further information with no reply received.
Grimer	2010	UK Guidelines for the Management of Bone Sarcomas	This hit was an outdated version of the 2016 document.
Van der Heijde	2013	EULAR definition of erosive disease in light of the 2010 ACR/EULAR rheumatoid arthritis classification criteria	Did not fulfil the criteria of a CPG – a consensus statement defining what was meant by erosive disease.
Klauser	2012	Clinical indications for MSK ultrasound: A Delphi-based consensus paper of the European society of MSK radiology	Did not fulfil the criteria of a CPG – a consensus-based educational framework.
Kulkarni	2015	BESS/BOA Patient Care Pathways Subacromial shoulder pain	It was not clear whether a systematic review had been conducted as part of the CPG development process (in order to meet the definition of a CPG) or whether a systematic review cited had been undertaken prior to CPG development in 2009. Authors were contacted in June 2019 for further information with no reply received.
Manchikanti	2015	Clinical management of radicular pain	Did not fulfil the criteria of a CPG – this was a review paper.
Moller	2017	The 2017 EULAR standardised procedures for ultrasound imaging in rheumatology	Did not fulfil the criteria of a CPG – a technical guideline outlining ultrasound scan procedure.
Nazarian	2013	Imaging algorithms for evaluating suspected rotator cuff Disease: Society of Radiologists in	Did not fulfil the criteria of a CPG – a consensus statement of what modality to order when for non-traumatic shoulder pain.

		Ultrasound Consensus Conference Statement	
Noorani	2019	BESS/BOA patient care pathways: Atraumatic shoulder instability	It was not clear whether a systematic review had been conducted as part of the CPG development process (in order to meet the definition of a CPG). Authors were contacted in June 2019 for further information with no reply received.
Peter	2011	Physiotherapy in Hip and Knee Osteoarthritis: Development of a practice guideline concerning initial assessment, treatment and evaluation.	CPG developed for intended use in the Netherlands only.
Pincus	2016	A Systematic Review and Appraisal of Clinical Practice Guidelines for MSK Soft Tissue Injuries and Conditions	Did not fulfil the criteria of a CPG – a systematic review of CPGs.
Post	2018	Patellofemoral Instability: A Consensus Statement From the AOSSM/PFF Patellofemoral Instability Workshop	Did not fulfil the criteria of a CPG – a consensus statement from a patellofemoral instability workshop.
Rangan	2015	BESS/BOA Patient Care Pathways Frozen Shoulder	It was not clear whether a systematic review had been conducted as part of the CPG development process (in order to meet the definition of a CPG). Authors were contacted in June 2019 following which the hit was excluded as it did not fulfil the criteria of a CPG. A systematic review was undertaken however, the systematic review upon which the CPG was based, was undertaken separately to the development process five years prior to CPG development (2010).
Schueller-Weidekamm	2014	Imaging and Interpretation of Axial Spondylarthritis: The Radiologist's Perspective—Consensus	Did not fulfil the criteria of a CPG – a consensus statement for imaging and interpretation of Axial Spondyloarthropathy.

		of the Arthritis Subcommittee of the ESSR	
Stochkendahl	2018	National Clinical Guidelines for non-surgical treatment of patients with recent onset low back pain or lumbar radiculopathy	CPG developed for intended use in Denmark only.
Tavee	2017	Low Back Pain	Did not fulfil the criteria of a CPG – this was a review paper.
Thomas	2016	BESS/BOA Patient Care Pathways Glenohumeral Osteoarthritis	It was not clear whether a systematic review had been conducted as part of the CPG development process (in order to meet the definition of a CPG). Authors were contacted in June 2019 following which the hit was excluded as it did not fulfil the criteria of a CPG. A systematic review was undertaken however, the systematic review upon which the CPG was based, was undertaken separately to the development process and published – this was not cited within the CPG.
Van Boxem	2010	Lumbosacral Radicular Pain	Did not fulfil the criteria of a CPG – this was a review paper.
Wise	2011	ACR Appropriateness Criteria on Acute Shoulder Pain	CPG developed for intended use in the United States of America only.

Appendix 8

An example completed Agree II that was undertaken to determine the individual quality assessment of each included CPG using a modified version of the Agree II tool; focusing on rigour of development.

Domain 3. Rigour of Development (%)	**Barton (2015) - PFP**	**Score (7)**
1. Systematic methods were used to search for evidence.	Systematic review methods were utilised. Multiple databases were searched, and these are outlined along with time interval. The search terms were outlined in the document as was the flow of included/excluded studies with rationale.	7
2. The criteria for selecting the evidence are clearly described.	A systematic review of systematic reviews was used to provide the evidence for these guidelines. These were not limited by language and both inclusion and exclusion criteria are clear.	7
3. The strengths and limitations of the body of evidence are clearly described.	The quality of the included reviews is clearly outlined; the guideline group used a specific quality appraisal tool for determining the quality of PFP reviews. To inform the final recommendations, only those deemed high quality were utilised. The individual domain scores from the quality appraisal tool are included as well as a section detailing the quality findings of all included systematic reviews. In addition, the section is well written and easy to understand. An individual presentation of the six included systematic reviews would enhance this section i.e. outcomes used.	6
4. The methods for formulating the recommendations are clearly described.	The process for formulating recommendations isn't entirely clear; it appears that the authors were the development group who formulated the recommendations by synthesis the SR evidence with qualitative interviews undertaken with identified experts. It's not clear how this process influenced recommendations or how a consensus was reached.	2
5. The health benefits, side effects, and risks have been considered in formulating the recommendations.	Whilst data for the benefits of interventions are considered and outlined. There does not appear to be any reporting of harm/side effects/risks nor how these are balanced or considered in the formulation of recommendations.	2
6. There is an explicit link between the recommendations and the supporting evidence.	The guideline is well referenced and with each recommendation, the reader is directed to the underpinning review evidence as well as the qualitative evidence of the invited experts. This section would be enhanced with an evidence summary table outlining the key features of the underpinning reviews.	6
7. The guideline has been externally reviewed by experts prior to its publication.	It is not evident that these recommendations were submitted for external review prior to publication.	1
8. A procedure for updating the guideline is provided.	There is no statement that the guideline will be updated nor are the methodology and criteria for updating the guideline reported.	1
Overall Score (%)	**57.1%**	**32**

Appendix 9 – Published website Scoping Review

PEC Innovation 1 (2022) 100040

Contents lists available at ScienceDirect

PEC Innovation

journal homepage: www.elsevier.com/locate/pecinn

Recommendations on patient-facing websites regarding diagnostic imaging for low back, knee, and shoulder pain: A scoping review

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ARTICLE INFO

Keywords:
Shoulder Pain
Low Back Pain
Knee Pain
Diagnostic Imaging
Public-facing websites

ABSTRACT

Objective: To describe and synthesise the content of public-facing websites regarding the use of diagnostic imaging for adults with lower back pain, knee, and shoulder pain.

Methods: Scoping review conducted in accordance with PRISMA guidance. A Google search was performed to identify public-facing websites that were either United Kingdom-based, or National Health Service affiliated. The DISCERN tool was used to appraise website quality before information regarding the use of imaging was synthesised using thematic analysis.

Results: Eighty-six websites were included, with 48 making reference to the use of imaging. The information within the majority (n = 43) of public-facing websites aligns with best available evidence. Where there is inconsistency, this may be explained by lower website quality. Three themes were apparent regarding the use of imaging – imaging to inform diagnosis and management; imaging in context; patient experience and expectations.

Conclusion: The recommendations and rationale for use of imaging contained within public-facing websites does not appear to justify the increase in imaging rates for musculoskeletal pain in the UK.

Innovation: Publicly available information following a novel search strategy, is largely aligned with best evidence, further understanding is required to determine reasons for requesting imaging from a patient and clinician perspective.

Contents

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http://dx.doi.org/10.1016/j.pecinn.2022.100040
Received 15 December 2021; Received in revised form 13 April 2022; Accepted 13 April 2022
Available online xxxx

1. Introduction

One of the most common reasons for consultation in primary care is musculoskeletal pain [1]. The most common areas affected are the lower back (LBP), knee and shoulder respectively [1,2]. In many situations, there is considerable clinical uncertainty in relation to the diagnosis to which symptoms of pain and reduced function can be attributed. Diagnostic imaging is increasingly being requested by primary care clinicians including general practitioners, nurses and physiotherapists [3-5,7], particularly where diagnostic uncertainty exists. It has also been reported that scan results are perceived by patients as authoritative [6].

It has been reported that in the five years between 2011/12 and 2016/17 there has been a 16% increase in the use of diagnostic imaging within the National Health Service (NHS) in England with the high demand from primary care being acknowledged as a challenge [7]. Within this challenge, patient expectations about diagnostic imaging have been suggested to be one factor that might explain the rise in imaging requests [7,8].

The NHS Long Term Plan [9] outlines how patients will have more control over their own health and more individualised care. To achieve this, the need for a fundamental shift in how clinicians work alongside patients is outlined, a model referred to as patient-centred care. Within a patient-centred care model, the encounter between the clinician and the patient is considered an equal encounter of negotiation whereby the patient is an active partner, with the patient-clinician relationship being one of interdependence through 'shared decision making' (SDM) [10]. This contrasts with a previously prevailing paternalistic relationship where the power sits with the clinician, and the patient is a passive recipient of care [11].

As of June 2019, 58.8% of the worldwide population have access to the internet [12]. It is suggested that 91% of adults in the United Kingdom (UK) use the internet [13] and that 73% use the internet as a source of healthcare information [14]. Increasing internet access, when combined with patient expectation as being a potential cause of increased use of diagnostic imaging within the NHS, needs to be considered within the wider context of a strategic prioritisation of individualised care informed by SDM. It is possible that the content within public-facing websites is informing patient expectations regarding the requirement for diagnostic imaging.

Despite the use of the internet for health information increasing, the quality of the information online remains varied [15-18]. Within an environment of mixed information, it can be difficult for patients to identify a trustworthy source. Further compounding this is that many patients may not have the capability to appraise website content nor recognise the strengths, weaknesses or credibility of the information [19]. To date, studies have focused on the quality and readability of website content in relation to specific disease processes [20] or specific body sites [21]. There is an absence of research identifying, describing, and synthesising content of written healthcare information related to specific components of clinical delivery, such as diagnostic imaging, across disease processes and body sites. Such research would allow for similarities and differences in relation to information provided to be identified as well as understanding how the website content aligns with best available evidence. In doing so, it can be established whether any differences seen are justified or reflect unwarranted variation, as well as highlighting priority areas for future development or informing potential educational or organisational strategies or policy, aimed at reducing unnecessary diagnostic imaging use.

There is a clear need to understand what online information exists that is available to patients about diagnostic imaging for musculoskeletal pain conditions. This scoping review is the first step towards that understanding. The aim of this scoping review was to describe and synthesise the content of public-facing websites with respect to the use of diagnostic imaging for adults with LBP, knee, and shoulder pain.

1.1. Review objectives

- To identify existing public-facing websites that may be used as sources of written healthcare information for people with LBP, knee, and shoulder pain.
- To describe and summarise website written content in relation to the use of diagnostic imaging for LBP, knee, and shoulder pain.
- To identify similarities and differences across websites and written information provided relating to the use of diagnostic imaging for those with LBP, knee, and shoulder pain in order to understand the influence of website quality on recommendation consistency with reference to best available evidence from clinical practice guideline (CPG) recommendations.

2. Methods

This scoping review was designed with reference to guidance from the Joanna Briggs Institute [22] and reported in line with the PRISMA guidance extension for scoping reviews [23]. The protocol for this scoping review was published previously via the Open Science Framework (osf.io/x3dq5) on the 21st February 2020. Any deviations from the protocol are outlined below.

2.1. Eligibility criteria

Public-facing websites were included if they:

- provided written healthcare information related to either LBP, knee, or shoulder pain (including advertising websites)
- were either based within the UK or were NHS affiliated.

Public-facing websites were excluded if they:

- were video-sharing platforms, such as YouTube or Google Video
- were audio-links
- were not publicly accessible
- were journal articles or journal websites

2.2. Search strategy & information sources

To inform the search strategy (including selection criteria of websites to be included within the review) a Patient and Public Involvement and Engagement (PPIE) meeting was held. This meeting was attended by five members of the public who have previously sought healthcare for various musculoskeletal conditions. The output of this meeting was a co-designed search strategy between the PPIE meeting attendees and the research team that replicated the search someone may perform to find out more about their symptoms, often prior to seeking help from a professional. It

was from this meeting that the review was restricted to UK-websites only, as PPIE attendees advised they would not visit international, or non-NHS affiliated websites.

The lead author (AC) entered the following search terms into the Google search engine on the 9th June 2020, as six individual searches:

- Low back pain
- Knee pain
- Shoulder pain
- Why does my back hurt?
- Why does my knee hurt?
- Why does my shoulder hurt?

To ensure that the first 50 hits remained constant throughout the review process, the website domain of each of the websites returned by the search was recorded in a Microsoft Excel (Microsoft Corp., Redmond, WA, USA) document. This ensured that the selection criteria could be independently applied by two reviewers (AC and TJ) without risk of the websites that were returned by the search being different.

2.3. Selection of sources of evidence

The selection criteria were independently applied by two members of the review team (AC and TJ) to each of the websites returned by the searches. A third member of the review team (CL) was available to arbitrate in the event of disagreement.

When viewing the websites, it was anticipated that multiple pages may need to be viewed in order to fully understand the context and obtain the information required to achieve the review objectives. As such, it was necessary to apply boundaries to the search to ensure consistency, reproducibility, and rigour. Within each website, a hyperlink, or Portable Document Folder (PDF) that led to information hosted within the same website was explored and included within the data extraction and analysis. A hyperlink which leads to information hosted within an external website was not explored or included within the data extraction. If multiple pages were viewed, or hyperlinks/PDFs explored within the same website this represented one 'hit' rather than multiple 'hits' in the context of the first 50 hits being reviewed.

2.4. Charting the results (data extraction)

The relevant characteristics of the included website(s) and the key data relevant to the review objectives were recorded in a charting table. A separate charting table was populated for lower back, knee, and shoulder websites **(Supplementary File 1)**

Data extraction was independently trialled by AC and TJ on the first five included websites to assess the suitability and capacity to chart all relevant information required to answer the review objectives. No changes to the data charting table were required. AC and TJ were the reviewers responsible for charting the results. A third member of the review team (CL) arbitrated in the event of disagreement.

2.5. Critical appraisal of individual sources of evidence

Quality appraisal within this review was used to explore the basis for any clear and substantial differences in recommendations between websites. The hypothesis was that those websites making substantially different recommendations to others would be explained by poorer quality. A clear and substantial difference in recommendation was defined as a website providing information that was not consistent with the recommendations contained within other websites, or the best available evidence. These were identified during Step 1 of the thematic analysis, informed by a recent scoping review that has synthesised CPG recommendations regarding the use of diagnostic imaging [24].

In order to understand whether website quality was the reason for clear and substantial differences in recommendations, the DISCERN Tool **(Supplementary File 2)** was used to appraise each website **(Supplementary File 3)**. The DISCERN Tool was chosen as its reliability has been demonstrated [19] and it has been used in similar reviews of website information [15,25]. Each website was appraised by AC using the DISCERN Tool and verified by TJ. A third member of the review team was available to arbitrate (CL) in the event of disagreement.

2.6. Synthesis of results

Extracted data **(Supplementary File 1)** was analysed using the six principles outlined by Braun and Clarke [26] whereby the aims of the thematic analysis are to identify, analyse and report patterns within the data.

The initial step involved familiarisation of the data extracted through a process of reading and re-reading (Step 1). During this process, codes were applied to aggregate the text (Step 2) before being organised together to form preliminary themes (Step 3). A theme is a broad unit of information that is made up of several codes grouped together to form a common idea [27]. This analysis was conducted independently by AC and verified by a second member of the review team (TJ). A third member of the review team was available to arbitrate (CL) in the event of disagreement. These preliminary themes were then critically reviewed by all members of the research team, refined, and iteratively developed (Step 4) in order to provide more meaning to the data prior to the final themes being defined (Step 5). The final step involved outlining the results of the analysis.

3. Results

The study selection process is depicted in **Figure 1**. From 300 identified websites, 214 were excluded leaving 86 public-facing websites included in the review.

3.1. Regional MSK condition

Within the websites included in this review, 38 (n = 14 for LBP; n = 14 for knee pain; n = 10 for shoulder pain) did not contain information on diagnostic imaging.

Of those public-facing websites that did provide recommendations or information on the use of diagnostic imaging (n = 48), 17 related to LBP, 15 for knee pain and 16 for shoulder pain.

Table 1 outlines the included websites and whether or not they made provided recommendations of information for imaging.

3.2. Public-facing websites and their recommendations or information on the use of diagnostic imaging

A charting table for LBP, knee, and shoulder pain was created to describe the identified public-facing websites that may be used as sources of written healthcare information and to describe the written content within these websites **(Tables 2 – 4 in Supplementary File 1).**

3.2.1. Critical appraisal within sources of evidence

There were five websites (two related to LBP, three for knee pain) with clear and substantial differences to the recommendations provided by other websites, and with reference to the best available evidence from CPG recommendations [24]. Each of these five websites [28-32] was categorised by the DISCERN Tool **(Tables 2-3)** as having serious limitations and in turn deemed not to be a useful source.

Of the 48 websites that provided recommendations or information on the use of diagnostic imaging, 16 (five related to LBP, six for knee pain and five for shoulder pain) were categorised as having serious limitations (scoring a 1 or a 2; **Supplementary File 2)** and in turn, not useful resources (including the five that make clear and substantially different recommendations). It would appear that clear and substantial differences related to imaging content may be explained by lower website quality, but not exclusively.

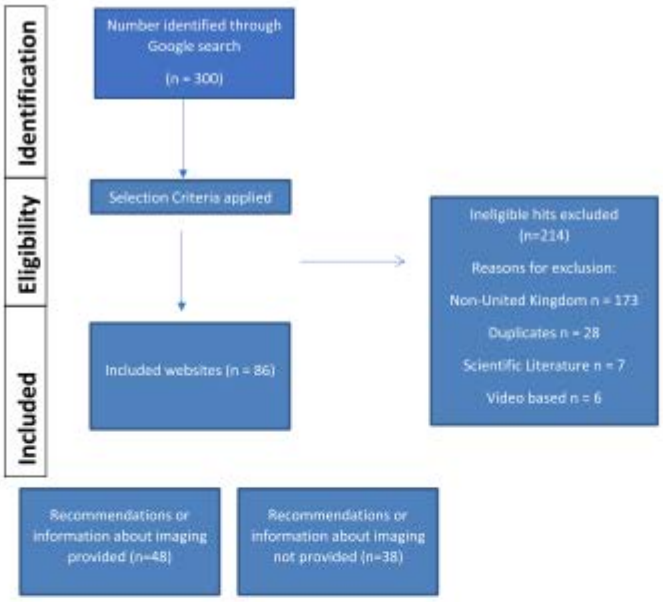

Fig. 1. Flowchart of the Selection Process.

3.3. Narrative synthesis

Following familiarisation, initial codes were labelled across the data set to identify text that were relevant to the research aims.

There were 20 initial codes **(Supplementary File 4)**. These initial codes were then reviewed and refined where commonality existed in order to provide more meaning to the data. This step resulted in the refinement of the 20 initial codes into five preliminary themes **(Figure 2)**.

To complete the synthesis, the preliminary themes were reviewed with reference to the coded data. This resulted in the refinement of the five preliminary themes into three main themes: 'Imaging to Inform Diagnosis and Management', 'Imaging in Context', and 'Patient experience and expectations'.

These three main themes were reviewed by the team with reference to both the coded data and the entire data set. This step in the process resulted in no further refinement, with the following themes identified within the written information of public-facing websites regarding imaging for LBP, knee, and shoulder pain.

3.3.1. Imaging to inform diagnosis and management

This theme was consistent across LBP, knee, and shoulder pain. The role of diagnostic imaging to inform diagnosis and management is a clear theme across the written information and recommendations within public-facing websites. These recommendations were framed within the context that a diagnosis is possible, and that imaging is the gold standard to both inform and confirm diagnosis:

> *An x-ray [35] can usually confirm the diagnosis* ***(kyphosis)****Chiropractors [36] rely on x-rays…and MRI scans for diagnosis* ***(low back pain)****…sometimes an x-ray [78] may be arranged if a clinician is uncertain* ***(knee pain)*** *…ultrasound or MRI can also be helpful in confirming a diagnosis of painful arc in* ***impingement syndrome*** *(104).*

This was particularly relevant where either a serious (such as cauda equina syndrome) or specific (such as a spondylolisthesis) pathology was suspected:

> *If* ***cauda equina syndrome*** *is suspected the patient must undergo an MRI urgently to confirm the diagnosis [34].*

In addition to the use of imaging in this context, recommendations also indicated that imaging should be used where symptoms have persisted despite treatment and the results of the imaging expected to change clinical management:

> *If your symptoms do not get better after treatment* ***(knee bursitis)****, you may be referred for further tests [75].In some cases [102] ultrasound or magnetic resonance imaging can be useful, these are only considered if it will guide treatment* ***(rotator cuff tendinopathy)****.*

3.3.2. Imaging in context

Aligned to, but in slight contrast to the above theme, the second theme related to the use of diagnostic imaging in context, again this theme was consistent across LBP, knee, and shoulder pain. The recommendations acknowledged the uncertainty underpinning the use of imaging, in particular the prevalence of changes seen on imaging in those populations without symptoms:

> *While people with low back pain [43] are more likely to have disc degeneration show up on an MRI, so will a large number of people without* **back pain***Osteoarthritis of the AC joint* ***(shoulder pain)*** *cannot be reliably diagnosed by X-ray as, although degeneration may be revealed, similar findings can be seen in asymptomatic individuals [108].There is a significant false*

Table 1
Included websites and whether or not they made provided recommendations of information for imaging.

Website Domain	Recommendations or information provided (Yes/No)
https://www.nhs.uk/conditions/back-pain/ ([35])	Yes
https://www.bupa.co.uk/health-information/back-care/back-pain [33]	Yes
https://www.nursingtimes.net/clinical-archive/pain-management/back-pain-23-03-2009/ [36]	Yes
https://www.versusarthritis.org/about-arthritis/conditions/back-pain/ [37]	Yes
https://www.your-pharmacy.co.uk/shop-by-brand/nurofen/back-pain/cat-2005?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B8u6y-92bfLAFhdshiwFeB4lxHtiF70eGFbjmFbESxZhc8zv41gZUcaAqBmEALw_wcB&gclsrc=aw.ds [38]	No
http://elitehealthchiropractic.co.uk/?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B-JscJJGW6FlpciBrrXXXEb0L5R-jqUGOXjdrJZQkaR1yWnNUhSgr8aABrEALw_wcB [39]	No
https://www.anadin.co.uk/whats-your-pain/back-muscle-pain?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B-j83XNdLF-ebETC2PYC_K4FGCnkNDG3uB6kRGtLRzbIWr3pe9VcR8aAqpnEALw_wcBb[40]	No
https://patient.info/bones-joints-muscles/back-and-spine-pain/lower-back-pain [41]	Yes
https://www.nice.org.uk/guidance/cg88 [42]	Yes
https://www.theguardian.com/society/2018/jun/14/back-pain-how-to-live-with-one-of-the-worlds-biggest-health-problems [43]	Yes
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/384519/low_back_pain.pdf [44]	Yes
https://www.royalberkshire.nhs.uk/patient-information-leaflets/Pain%20Management/AandE%20Back%20pain%20non%20specific%20lower%20back%20pain.htm [45]	Yes
https://www.physio-pedia.com/Low_Back_Pain [34]	Yes
http://crosbyphysio.com/what-we-can-treat/spinal/low-back-pain/ [29]	Yes
https://www.zivaa.com/strong-after-section/?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B_N04cdXigYefHsC7zgYk0cJwFPyKBJKs8T629v2ZErA9uycrGANu4aAghnEALw_wcB [46]	No
https://www.gentle-chiropractic.co.uk/ [47]	No
https://www.happypsoas.co.uk/?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B_r0t6zPhyk2O36WTiu4n24HvGDX7lxrAQMN4e-ti9kpRH8mmRjJrgaAhk6EALw_wcB [48]	No
https://chiropractic-uk.co.uk/back-pain/ [49]	Yes
https://www.sportsinjuryclinic.net/sport-injuries/back/low-back-pain [50]	Yes
https://www.ouh.nhs.uk/patient-guide/leaflets/files/5712Plowbackpain.pdf [51]	No
https://www.qvh.nhs.uk/wp-content/uploads/2015/09/Chronic-Lower-Back-Pain.pdf [52]	Yes
https://www.theguardian.com/lifeandstyle/2015/nov/30/everything-you-ever-wanted-to-know-about-back-pain-but-were-afraid-to-ask [53]	Yes
https://www.leukaemiacare.org.uk/support-and-information/latest-from-leukaemia-care/blog/could-muscle-or-back-pain-indicate-leukaemia/?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B9TdHPxx1TDamtbD64HQ2JzPH6-xuQ26FbXXbjXmaAKT4TvuCireQaAw1EALw_wcB [54]	No
https://www.back-pain-mri.com/?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B8wow9nAsvACifbODwiQTZ2-srqgJaFqHS9jKbo-9Ea1CriZMoPoYaAvLqEALw_wcB [28]	Yes
https://topmri.com/?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B9WnHQSTDh7QtxW1jT7Kg8oo4tTExH6rpfW9GpIPakgBs704ILBAq4aAjpyEALw_wcB [55]	No
https://www.brainandspine.org.uk/supporting-you/helpline/?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B-ohMBHK-hxtm-d3nfeDZYLMpFEIZ7xz5YQPVvdF7CTy5nvhoaz3d0aAIbKEALw_wcB [56]	Yes
https://blog.sfceurope.com/why-is-my-back-aching-after-a-shift [57]	No
https://www.manchestereveningnews.co.uk/news/fashion-news/why-does-my-back-hurt-during-sex-986123 [58]	No
https://www.capitalphysio.com/fitness/lower-back-pain-from-squats-why-this-happens-and-how-to-avoid-it/ [59]	No
https://www.refinery29.com/en-gb/lower-back-pain [60]	No
https://www.independent.co.uk/life-style/health-and-families/features/back-pain-i-was-only-in-my-early-thirties-ndash-but-i-felt-like-an-old-lady-1975563.html [61]	No
https://www.amazon.co.uk/s?k=knee+pain&adgrpid=55947714471&gclid=Cj0KCQiA7OnnBRCNARIsAIW53B8FKCAcP8-vF9suxP8r4og_BKXfwmS8iy0lqEjpWyJE774bvVerwgaAnPQEALw_wcB&hvadid=259047401210&hvdev=c&hvlocphy=1007064&hvnetw=g&hvqmt=e&hvrand=12489158696302928342&hvtargid=kwd-10397122&hydadcr=170_1736084&tag=googhydr-21&ref=pd_sl_80h8usedd9_e [62]	No
https://www.nhs.uk/conditions/knee-pain/ [63]	Yes
https://www.versusarthritis.org/about-arthritis/conditions/knee-pain/ [64]	Yes
https://www.bupa.co.uk/health-information/knee-clinic/explore-knee-pain [65]	Yes
https://www.voltarol.co.uk/pain-treatments/knee-pain/ [66]	Yes
https://www.runnersworld.com/uk/health/injury/a773762/4-causes-of-knee-pain-and-how-to-fix-them/ [67]	No
https://uk.hisamitsu/?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B8SuM6rlbVl_UBJ-jOY8vjnu4d9p0MlUU7B3HfDdf_H49fsD0JaKEaAkbMEALw_wcB [68]	No
https://www.ultralieve.com/?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B_BF2uYTBVG1kZwgJV7Pc7MON8BkKld_2LS1hoyU_WiEL4uFDqeU7aaAiL5EALw_wcB [69]	No
https://www.blackberryclinic.co.uk/landing_page/prolotherapy/?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B_M0Sev0CQg2X4jscRdlBQp7-5Xu1FDXx7heuld-xAUEJORYf2qP4aAtmVEALw_wcB [70]	Yes
https://www.active650.co.uk/products/full-knee-support?gclid=Cj0KCQiA7OnnBRCNARIsAIW53B_5xdiompkHtmzv9mdU_WaBHHiicZxI4Nb4s4KfMw6UNO--_2AWptIaAgAwEALw_wcB [71]	No
https://www.sportsinjuryclinic.net/sport-injuries/knee-pain [72]	Yes
https://www.csp.org.uk/public-patient/rehabilitation-exercises/knee-pain [73]	No
http://www.southend.nhs.uk/media/188240/kneepaininyoungadults.pdf	Yes
http://physio.hey.nhs.uk/common-injuries/lower-limb-injuries/knee-pain [74]	No
https://www.nidirect.gov.uk/conditions/knee-pain [75]	Yes
https://patient.info/doctor/anterior-knee-pain [76]	Yes
https://www.circlehealth.co.uk/integratedcare/knee-pain/ [77]	No
https://www.nwbh.nhs.uk/knee [78]	Yes
https://www.avogel.co.uk/health/muscles-joints/joint-pain/knee-pain/ [79]	No
https://www.iosteopathy.org/what-we-treat/knee-pain/ [80]	Yes
https://www.capitalphysio.com/health-news/inside-knee-pain/ [81]	No
https://www.justanswer.co.uk/sip/orthopedics?r=ppc|ga|5|1683661621|64841937079|&JPKW=%2Bknee%20%2Bpain&JPDC=S&JPST=&JPAD=326911692843&JPMT=b&JPNW=g&JPAF=txt&JPRC=1&JPCD=20190122&JPOP=&JCLT=&cmpid=1683661621&agid=64841937079&fiid=&tgtid=kwd-18904474954&ntw=g&dve=c&gclid=Cj0KCQiA7OnnBRCNARIsAIW53B_B7EGcJjrBvQCMvk_9x3IT1MF6cxag-MFK0BqtehHb6ivoYichsUsaAihEALw_wcB [82]	No
http://rahulpatel.net/ [30]	Yes

(continued on next page)

Table 1 (continued)

Website Domain	Recommendations or information provided (Yes/No)
https://acuraflex.co.uk/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B-Qe2YAeQ1pSFd5P0YwhAvErbBc1XCkZYXAU2rTU3DRYs7XhaRFrbAaAuyPEALw_wcB [31]	Yes
https://www.nurofen.co.uk/blogs/symptoms-advice/muscular-pain?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9HSWU1P2HqW3dyAv9zhlIAEs1uG4lAblXCOkyZn3VBF9PdnY_GakMaAkMCEALw_wcB&gclsrc=aw.ds [83]	No
https://www.osmopatch.co.uk/conditions/knee-pain/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B8wE8cHKNIrUj-C0mYdN30AysXAapE5bZmaWvvsr2jFQHAsqJIhlaAj1KEALw_wcB [32]	Yes
https://www.bmihealthcare.co.uk/health-matters/health-and-wellbeing/whats-wrong-with-my-knee [84]	Yes
https://www.betterbraces.co.uk/injury-info-center/knee-injury-guide/inside-knee [85]	No
https://actesso.co.uk/knee-supports-for-injury/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9OQaUihEeVOmhQGwZtMfA1NKnxRauFhl0zg455jzkP7mWLVNi5AaAmuvEALw_wcB [86]	No
https://www.amazon.co.uk/s?k=shoulder+pain&adgrpid=52358118199&gclid=Cj0KCQiA7OnxBRCNARIsAIW53B-0UZn4rtwFjHHxgAnk5z5SdRuGeatbWwdVGXReHr6dJ-tUval1vBYaAgyjEALw_wcB&hvadid=259085132347&hvdev=c&hvlocphy=1007064&hvnetw=g&hvpos=1t2&hvqmt=e&hvrand=10602600090041679011&hvtargid=kwd-11565081&hydadcr=28148_1724781&tag=googhydr-21&ref=pd_sl_2ww9uipky9_e [87]	No
http://www.shoulder2wrist.co.uk/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9j7PArYvk7j3jIG7IUVE3WLhHQDsgXEB1tZWZnVPkt8i7A1bwtohgaAizBEALw_wcB [88]	Yes
https://www.versusarthritis.org/about-arthritis/conditions/shoulder-pain/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B-0kIEWEDGW5YZbTunEoMuESI5Qua_X5VihexppppeF2FDV44Uz6AaAvFIEALw_wcB [89]	Yes
https://www.nhs.uk/conditions/shoulder-pain/ [90]	Yes
https://www.csp.org.uk/public-patient/rehabilitation-exercises/shoulder-pain [91]	No
https://www.voltarol.co.uk/pain-treatments/shoulder-pain/ [92]	Yes
https://cks.nice.org.uk/shoulder-pain [93]	Yes
https://www.ibuleve.com/products?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9TYcEqt0CBD7CytI0kANm4ME5QbNjBOTdV40tch6yX_93m3ICzIAaAhfnEALw_wcB&gclsrc=aw.ds [94]	No
https://www.shoulderunit.co.uk/?gclid=Cj0KCQiA7OnxBRCNARIsAIW53B_3RUi0vYyb5DRaXmH-E_Hbn5eFhiIEb-C9s-wVEfr9q9WKMNWgS0aAnT7EALw_wcB [95]	Yes
https://www.izito.co.uk/ws?q=shoulder%20pain%20treatments&asid=iz_uk_2_010_010&mt=b&nw=g&de=c&ap=1o3&ac=1913&gclid=Cj0KCQiA7OnxBRCNARIsAIW53B9XTyfxN9nDivoL6qi_U5499ojYfNUp7K8pCbTPooUuPwJ7W2IHMp8aAn5_EALw_wcB [96]	No
https://patient.info/bones-joints-muscles/shoulder-pain-leaflet [97]	Yes
https://www.shoulderunit.co.uk/services/shoulder-pain/ [98]	Yes
https://www.highgatehospital.co.uk/gp-news/experiencing-shoulder-pain/ [99]	No
https://www.nhsinform.scot/illnesses-and-conditions/muscle-bone-and-joints/self-management-advice/shoulder-problems [100]	No
https://www.nwbh.nhs.uk/shoulder-pain [101]	Yes
https://ahpsuffolk.co.uk/Home/SelfHelp/ShoulderPain.aspx [102]	Yes
https://www.hacw.nhs.uk/shoulder-pain/ [103]	No
http://www.southend.nhs.uk/media/188256/shoulderpainincexercise.pdf [104]	Yes
https://www.sportsinjuryclinic.net/sport-injuries/shoulder-pain [105]	Yes
https://www.orthteamcentre.co.uk/?gclid=Cj0KCQiAsvTxBRDkARIsAH4W_j_aMx0Pu4YQP8LW2NmY79aSCzu_zdBvdEI2pSTfZLI303LzGZwVp-caAiT5EALw_wcB&gclsrc=aw.ds [106]	Yes
https://claiminjurynationwide.co.uk/slp/shoulder-injury?src=google&kw=shoulder%20injury&gclid=Cj0KCQiAsvTxBRDkARIsAH4W_j-4qZYf8yYvnHjz6HwMeDGanl19GjCW7O-VM3WkIkwpJvoyk7Xh-iYaAp9tEALw_wcB [107]	No
https://patient.info/doctor/shoulder-pain-pro [108]	Yes
https://www.cancerresearchuk.org/about-cancer/cancer-chat/thread/shoulder-pain-becomes-breast-cancer [109]	Yes
https://www.topdoctors.co.uk/medical-articles/why-does-my-shoulder-hurt-the-many-causes-of-shoulder-pain [110]	Yes
https://www.popsugar.co.uk/gdpr-consent?destination=https%3A%2F%2Fwww.popsugar.co.uk%2Ffitness%2FWhy-Does-My-Shoulder-Hurt-When-I-Run-46471666 [111]	No
https://www.amazon.co.uk/s?k=shoulder+pain+relief&adgrpid=52866675013&gclid=Cj0KCQiAsvTxBRDkARIsAH4W_j_5aDFlLe4olydo9-yqTYaJujMZRUxuYe4C5VORm9wlM2P2O2gCzfMaAqbkEALw_wcB&hvadid=259095991427&hvdev=c&hvlocphy=9046265&hvnetw=g&hvqmt=b&hvrand=3819357589190251425&hvtargid=kwd-487953133432&hydadcr=28176_1821090&tag=googhydr-21&ref=pd_sl_5y58ppobh8_b [112]	No

positive rate from MRI of the knee. Abnormal findings have been reported in health individuals with no knee symptoms [76].

Within such a context, the possibility of overuse of diagnostic imaging is outlined with reference to consideration of whether imaging is required, and if obtained, should be interpreted in the context of the clinical presentation, rather than in isolation:

> *Radiographs and MRI of CT scans are often obtained* ***(low back pain).*** *Abnormalities are frequently found in such imaging. This is often unrelated to symptoms and should be interpreted in the context of the clinical picture [44].Diagnosis is usually made from the patient's history and a simple examination without the need for further investigations* ***(knee pain).*** *Sometimes an x-ray may be arranged if a clinician is uncertain about the diagnosis or wishes to see the extent of the osteoarthritis [78].X-rays are good for looking for problems with the bones in your shoulder and minor changes in the joints [89]. However, small changes are quite common and may not be the cause of your trouble* ***(shoulder pain).***

3.3.3. Patient experience and expectations

Where an investigation is required, what to expect from the process and what imaging modality to expect is described. In particular, what to expect from the process is outlined for the less common imaging modalities such as DEXA [33] and CT Scan [34]:

> *If your doctor thinks you may have* ***osteoporosis,*** *they may suggest you have a DEXA (dual energy x-ray absorptiometry) scan to measure the density of your bones. The scan is readily available and involves lying on a couch, fully clothed, for about 15 minutes while your bones are x-rayed [37].An ultrasound scan can show swelling [89], as well as damage and problems with the tendons, muscles, or other soft tissues in the shoulder. It uses high-frequency sound waves to examine and build pictures of the inside of the body* ***(shoulder pain).*** *MRI scanning [76] may give much more detail of soft tissues but changes seen may not correlate with the degree of symptoms* ***(anterior knee pain).***

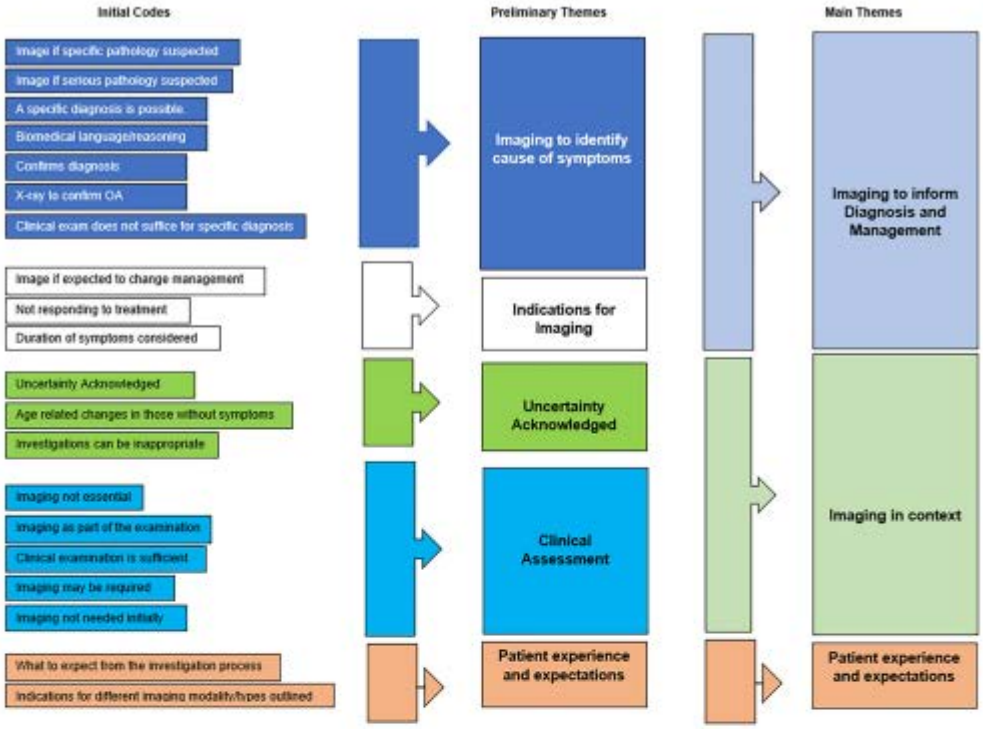

Fig. 2. Themes identified from the recommendations or information provided within public-facing websites on the use of diagnostic imaging for LBP, knee, and shoulder pain. *Colour when in print.*

There was consistency with regard to x-ray being utilised as a first-line investigation if the suspected diagnosis is related to the bone i.e. fracture, with a CT scan reserved as a second-line investigation following x-ray if further detail is required:

> ***Spondylolisthesis** can easily be confirmed by taking an X-ray of your spine from the side while you're standing. This will show whether a bone in your spine has slipped out of position or if you have a fracture. If you have pain, numbness, tingling or weakness in your legs, you may need additional tests, such as a CT scan or an MRI scan [35].*

Where a suspected diagnosis is not related to the bone i.e. soft tissue injury, there was again consistency in that for those with LBP or knee pain an MRI scan is the investigation of choice to both assess the soft tissues but also to rule out serious pathology:

> *X-rays aren't usually helpful as cartilage doesn't show up on the x-ray **(patellofemoral pain)**. Your doctor may suggest an MRI scan, for example if you've received a blow to your knee [74].*

Whilst for the shoulder, an Ultrasound Scan (USS) was recommended as the first-line investigation with an MRI scan reserved as a second-line investigation following USS, should further detail be required:

> *Ultrasound is the examination of choice **(biceps tendinopathy)** …MRI scan can demonstrate the whole course of the biceps tendon (including the intra-articular tendon and related intra-articular pathology). However, it is not appropriate or cost-effective for routine use. It is indicated after unsuccessful rehabilitation or where there is suspected rotator cuff or labral tear injury [108].*

4. Discussion and conclusion

4.1. Discussion

The aim of this scoping review was to describe and synthesise the content of public-facing websites with respect to the use of diagnostic imaging for adults with LBP, knee, and shoulder pain. To the author's knowledge, this represents the first review of its kind with reference to describing and synthesising public-facing websites and reviewing the written information and recommendations for use of diagnostic imaging within these. This review identified three main themes that when combined, outline the key messages contained within public-facing websites regarding the use of diagnostic imaging for LBP, knee, and shoulder pain: (i) imaging to inform diagnosis and management; (ii) imaging in context; and (iii) patient experience and expectations.

Of the 48 websites that including recommendations or information on diagnostic imaging, there were five (n = 2 related to LBP, n = 3 for knee pain) websites with clear and substantial differences to the recommendations provided by other websites, with reference to the best available evidence. These five websites each demonstrated serious limitations and in turn were considered not to be useful sources of information. However, other websites for LBP (n = 3) and knee pain (n = 3) which were also identified as having serious limitations, provided recommendations that were

consistent with those provided by websites deemed useful and appropriate. None of the included websites for shoulder pain made recommendations regarding imaging that were clear and substantially different. However, five of the included shoulder websites demonstrated serious limitations and were considered to not be useful sources of information. It would appear that clear and substantial differences related to imaging content may be explained by lower website quality, but not exclusively. Other factors not explored as part of this review, such as credibility, currency or comprehensiveness may explain this difference [21].

The findings of this scoping review suggest that the majority of written information and recommendations within public-facing websites are consistent with the recommendations within CPGs that inform UK clinical practice. A recent scoping review concluded that routine use of diagnostic imaging should be discouraged and reserved for clinical circumstances where there is a suspicion of specific or serious pathology, or where the person is not responding to initial non-surgical management and the imaging result is expected to change that persons clinical management [24]. SDM involves clinicians and patients sharing the best available evidence, with patients being supported to consider options [113]. This consistency between information and recommendations within public-facing websites and CPGs is a key enabler to effective SDM and personalised care. Despite this consistency, there is a lack encouragement for patients to engage with SDM contained within public-facing websites with only seven of the 48 included websites **(Supplementary File 3)** explicitly encouraging SDM [33,36,42,56,65,97,114].

With the use of diagnostic imaging increasing within primary and intermediate care in the UK, patient expectations or beliefs have been suggested to be one factor that might explain the rise in imaging requests [7,8,115]. It has been shown in the UK that 96% of people are satisfied with the health-related information that they have seen on the internet, with 61% of people obtaining health information via the internet over a 12-month period [116]. For those with shoulder pain [117], more people utilised internet searches (52.5%) to obtain health-related information than consulting their physiotherapist (49.2%) or their family and friends (14.2%). Given the consistency between public-facing website recommendations and clinical guideline recommendations, and the extent to which the internet is used by the public and patients to obtain health-related information, the written information contained within the public-facing websites does not appear to explain the increase in imaging rates seen in the UK. Future research should look to understand the reasons for requesting diagnostic imaging for musculoskeletal pain conditions affecting the LBP, knee, or shoulder, from the perspective of the referring clinician and patients.

The written information contained within public-facing websites, being consistent with clinical guideline recommendations, is not a constant finding within the wider literature. A systematic review of the credibility, accuracy and comprehensiveness of treatment recommendations for lower back pain contained within public-facing websites demonstrated that the majority of websites did not demonstrate credibility, lacked comprehensiveness and provided a high proportion of inaccurate recommendations when compared to those within CPGs [21]. The difference in consistency found between website information and CPG recommendations within this systematic review and the current scoping review, may be explained by the difference in area of research focus as well as the methods used, which introduce greater potential for variation. The systematic review by Ferreira et al. [2019] focused on recommendations for treatment within CPGs, rather than recommendations for use of diagnostic imaging. With regard to methods used, the search strategy employed within the systematic review was developed by the research team, rather than co-produced through PPIE. The current scoping review limited websites to those that were either UK-based or NHS affiliated whilst the systematic review included websites that were based in five major English-speaking countries, with the majority of included websites being based in the United States. Further, whilst the current scoping review included public-facing websites for LBP, knee, and shoulder pain, the systematic review included websites for LBP only [21].

To date, this represents the first review of its kind with reference to describing and synthesising public-facing websites. Within this review the written information and recommendations for use of diagnostic imaging were summarised, appraised, and comparted to the best available evidence. The strengths of this scoping review include that it was conducted in accordance with good practice as recommended for the conduct of scoping reviews [22] and the methods have been reported transparently, allowing for replication, including the previous publication of the protocol.

The involvement of a patient group to design the search strategy should be considered a strength within the context of this review. Within the PPIE meeting, video sources of information were not discussed, and as such the subsequent focus of this review being on written information contained within the public-facing websites. Therefore, a pragmatic approach was taken to limit the focus of this review to written information. The limitation of this is acknowledged in that video-based content is becoming increasingly popular and utilised [118]. Future research should look to messages contained within publicly available video-based content to understand the recommendations within such a medium to the public regarding the use of diagnostic imaging. Within a scoping review, critical appraisal is not used to inform risk of bias and subsequent interpretation as it would within a systematic review which may influence the interpretation of the results.

4.2. Innovation

Increasing internet access, when combined with patient expectation has been seen as a potential cause of increased use of diagnostic imaging within the NHS, influencing beliefs regarding the necessity and utility of diagnostic imaging for musculoskeletal pain. This review frames innovation generally, using a novel search strategy designed with patients to replicate a search for information that that they would undertake should they have lower back, knee, or shoulder pain when they are looking for health information. The results demonstrated that the written information contained within public-facing websites is largely aligned with best evidence, and in turn does not appear to explain the increase in imaging rates observed.

4.3. Conclusion

The key messages contained within public-facing websites regarding the use of diagnostic imaging outlined what patients should expect in terms of imaging modality and the experience when undergoing less common modalities. Where imaging is used, it should be to inform diagnosis and management within the context of the clinical presentation, rather than in isolation.

Written information contained within public-facing websites does not appear to explain the increase in imaging rates seen in the UK for these common musculoskeletal pain presentations. Future studies should seek to understand the reasons for requesting diagnostic imaging for musculoskeletal pain affecting the LBP, knee, or shoulder, from the perspective of the referring clinician and patients.

Funding

This work was supported by an ACORN PhD Studentship from Keele University, and a PhD Studentship from Manchester Metropolitan University.

CRediT authorship contribution statement

Andrew Cuff: Conceptualization, Methodology, Validation, Formal analysis, Data curation, Investigation, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition. **Thomas Jesson:** Methodology, Validation, Formal analysis, Data curation, Investigation, Writing – review & editing. **Gillian Yeowell:** Formal analysis, Writing – review & editing, Project administration, Supervision. **Lisa Dikomitis:** Conceptualization, Supervision. **Nadine E. Foster:** Conceptualization, Supervision. **Chris Littlewood:** Formal analysis, Validation, Writing – review & editing, Project administration, Supervision.

Declaration of Competing Interest

The authorship declares **no competing interests**. Competing interests are defined as those potential influences that may undermine the objectivity, integrity, or perceived conflict of interest of a publication.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pecinn.2022.100040.

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Appendix 10 - Website Scoping Review (2) Protocol

Research Team

Lead: Andrew Cuff (AC) – PhD Student

Dr Chris Littlewood (CL) – Lead Supervisor

Thomas Jesson (TJ) – Physiotherapist

Prof Nadine Foster (NF) - Supervisor

Dr Lisa Dikomitis (LD) - Supervisor

Title

Recommendations on public-facing websites regarding diagnostic imaging for low back, knee and shoulder pain: a scoping review

Background

Reports have described that in the five years between 2011/12 and 2016/17 there has been a 16% increase in the use of diagnostic imaging within the National Health Service (NHS) in England with the high demand from primary care being acknowledged as a challenge. Patient expectations about diagnostic imaging have been suggested to be one factor that might explain the rise in imaging requests.

MSK (MSK) pain conditions are one of the most common reasons for primary care consultation. The epidemiological evidence of the prevalence of MSK pain presentations suggests that the most common body sites for MSK pain in the spine, lower limb and upper limb are the low back, knee and shoulder respectively. In many situations, there is considerable clinical uncertainty in relation to the diagnosis to which symptoms of pain and reduced function can be attributed. Diagnostic imaging including x-ray, diagnostic ultrasound and magnetic resonance imaging (MRI) are increasingly being requested by primary care clinicians including GPs, nurses and physiotherapists, particularly where diagnostic uncertainty exists. It has also been reported that scan results are perceived by patients as authoritative.

The Long Term Plan outlines how, within the NHS, patients will have more control over their own health and more individualised care. To achieve this, the need for a fundamental shift in how clinicians work alongside patients is outlined, a model referred to as patient-centred care. Within a patient-centred care model, the encounter between the clinician and the patient is considered an equal encounter whereby the patient is an active partner, with the patient-clinician relationship being one of interdependence. The dialogue within the consultation is bidirectional, ensuring that the perspective of the patient is understood and considered. This contrasts with a paternalistic relationship where the locus of power sits with the clinician, and the patient is a passive recipient of care.

Underpinning such a model of healthcare is the notion of ‘shared decision making’ (SDM). SDM has been defined as “an approach where clinicians and patients share the best available evidence when faced with the task of making decisions, and where patients are supported to consider options, to achieve informed preferences”. This involves the patient and the clinician

reaching a decision regarding healthcare collaboratively having discussed available options, associated risks and benefits alongside the expectations, values and preferences of the patient.

It has been recognised that the beliefs and expectations of the patients with MSK pain conditions can influence their clinical outcomes such as pain and function and that patients are increasingly using the internet as a resource for obtaining information about health conditions and healthcare. Unlike more traditional forms of media, the internet is not under universal editorial control and those uploading content are able to influence their standing through marketing and paid advertisements. Whilst some sources of health information on the internet will be subject to independent review, as with research publications, this does not ensure validity. As such, online information related to healthcare is largely unregulated and can vary in both accuracy and quality.

Despite the use of the internet for health information increasing, it appears that the quality of the information still remains varied. A study from 2005 demonstrated that most of the online information related to osteoarthritis (OA) was of poor quality whilst a more recent study published in 2018 demonstrated that the majority of online information was now of a high standard however, wide variety within this information still remains Whilst improvements have been seen for OA, the quality of online information appears to have remained poor for low back pain (LBP). A cross-sectional study in 2003 demonstrated that the majority of online information for LBP was of poor quality and a more recent study published in 2012 corroborated this finding with the information provided not being uniformly consistent with recommendations from clinical practice guidelines.

Within this heterogenous information environment, it can be difficult for patients to identify a trustworthy source. Further compounding this is that many patients may not have the capability to appraise website content nor recognise the strengths, weaknesses or credibility of the information. To date, studies have focused on the quality and readability of website content in relation to specific disease processes e.g. OA or specific body site e.g. LBP. There is an absence of research identifying and mapping content of written healthcare information related to specific components of clinical delivery, such as diagnostic imaging, across disease processes and body sites. Such research would allow for similarities and differences to be identified as well as understanding how the website content aligns with best available evidence. In doing so, it can be established as to whether any differences seen are valid or reflect unwarranted variation, as well as highlighting priority areas for future development or informing potential educational strategies aimed at reducing unnecessary diagnostic imaging use.

As of June 2019, 58.8% of the worldwide population have access to the internet. It is suggested that 91% of adults in the UK use the internet and that 73% of UK adults use the internet as a source of healthcare information. Increasing internet access, when combined with patient expectation as being a potential cause of increased use of diagnostic imaging within the NHS needs to be considered within the wider context of a strategic prioritisation of individualised care informed by shared decision making. There is a clear need to better understand the range and potential impact of online information available to patients about diagnostic imaging for MSK pain conditions. This scoping review is the first step towards that aim.

Review Objectives

- To identify existing public-facing websites that may be used as sources of written healthcare information in those with LBP, knee and shoulder pain.

- To describe and summarise website written content in relation to the use of diagnostic imaging for LBP, knee and shoulder pain.

- To identify similarities and differences across websites and written information provided in relation to the use of diagnostic imaging for those with LBP, knee and shoulder pain.

Methods

Design

The aim of this scoping review is to identify and map the content of public-facing websites with respect to the use of diagnostic imaging for adults with LBP, knee and shoulder pain.

A scoping review has been chosen as the appropriate method given this enables identification and charting of this topic in order to clarify key concepts

This scoping review has been designed with reference to guidance from Peters et al. 2015 and Tricco et al. 2018. Within a scoping review, the search strategy is intended to be comprehensive with each stage of the search and the process of search strategy development clearly outlined. To inform the search strategy (including selection criteria of websites to be included within the review) a Patient and Public Involvement and Engagement (PPIE) meeting was conducted. This meeting was attended by five members of the public who have all sought healthcare for various MSK (MSK) conditions previously. The output of this meeting was a co-designed search strategy between the PPIE meeting attendees and the research team.

The PPIE group was in general agreement that they would not necessarily seek clinical guidance at the onset of their MSK pain and would give the problem time to resolve. If the problem did not resolve they were more likely to seek information to better understand their problem and guide their expectations. The attendees agreed that the online search engine Google would be the means of the information search. An initial search strategy was drafted by the lead author (AC) within the PPIE meeting and then refined by the PPIE group.

The initial draft search strategy consisted of the following terms:

- Back pain
- Knee pain
- Shoulder pain

When utilising Google, the PPIE group was unanimous that they would be very specific in their search by describing their symptoms and that the above initial draft search strategy was too broad. The suggested approach was to utilise both a broad search and a more specific search. As such, the following search strategy was agreed upon by the PPIE group, comprising six individual searches in Google:

    - Low back pain
    - Knee pain
    - Shoulder pain
    - Why does my back hurt?

- Why does my knee hurt?
- Why does my shoulder hurt?

Previous published reviews of public-facing websites have limited their searches to the first 50 websites. With the PPIE meeting this approach was discussed. The majority of participants stated that they would not visit more than two or three websites from their search and would never go beyond the first page (of listings of 'hits') as, from experience, these websites often appear to be less relevant. The PPIE group agreed that for the purpose of this research study, limiting the search to the first 50 websites in line with previous research was acceptable and should provide a comprehensive search of websites.

The following selection criteria will be used to determine which websites are included within this review.

Table 1: Criteria for inclusion within the scoping review of public-facing websites that may be used as sources of written healthcare information in those with LBP, knee and shoulder pain.

Criterion	Justification
Public-facing websites providing written healthcare information related to either LBP, knee or shoulder pain (including advertising websites) that are either based within the United Kingdom (UK) or are NHS affiliated.	The focus of this review is on the low back, knee and shoulder. This focus stems from epidemiological evidence of the prevalence of these MSK pain presentations; they represent the most common body sites for MSK pain in the upper limb, lower limb and spine, respectively. This will provide opportunity to compare and contrast between the most researched area of LBP and the lesser researched upper limb and lower limb. The PPIE group explained that they would visit a website for healthcare information if it appeared trustworthy. There was unanimous agreement that a website appeared a trustworthy source if it was either based in the UK or if the website was NHS affiliated. If the website did not meet this criterion then the attendees described that they would not visit this website. A website is considered to be NHS affiliated if it possesses a nhs.uk domain or contains 'nhs' within the Uniform Resource Locator (URL). A website is considered to be based within the UK if it has a .uk domain. Those websites where it is unclear, for example those with a .org, .net or .com domain will be visited to determine host country.

	Public-facing websites that do not contain information relevant to diagnostic imaging will still be including in the charting of the results, consistent with the function of a scoping review to map the available information related to the topic of interest. Those websites that are included but do not contain information relevant to diagnostic imaging will not be quality appraised as quality appraisal is not a compulsory stage of a scoping review and is regarded as optional.

Table 2: Criteria for exclusion within the scoping review of public-facing websites that may be used as sources of written healthcare information in those with LBP, knee and shoulder pain.

Criterion	Justification
Video-sharing platforms such as YouTube or Google Video or audio links.	The focus of this scoping review is to evaluate the written information provided on public-facing websites, rather than that provided in other multimedia formats such as audio or video. The limitation of this is acknowledged in that video content is becoming increasingly popular and utilised. Within the PPIE meeting, video sources were not discussed. Whilst this may not fully represent public and patient perspective, within the wider aims of the research programme this scoping review is intended to inform the subsequent qualitative investigations. To include video content would also lead to the need to consider the inclusion of audio content as well as the need to include different methods of critical appraisal. With this in mind, and for pragmatic reasons within the context of a PhD where the aim is to inform the next stage of the PhD rather than be comprehensive in its own right, a decision has been made to focus on written information within this review, acknowledge this limitation and recommend that future research explore this space.
Non-accessible websites	Websites that are not freely accessible to the public e.g. behind a paywall or require

	subscription, are unlikely to be explored by patients
Journal articles or websites.	The focus of this review relates to public-facing websites, whilst some patients may engage with scientific literature, this is unlikely to be representative of the wider patient population.

Search Strategy

A comprehensive search strategy will be used in accordance with recent guidance for conducting a scoping review.

The lead author will enter the following search terms into the Google search engine as six individual searches:

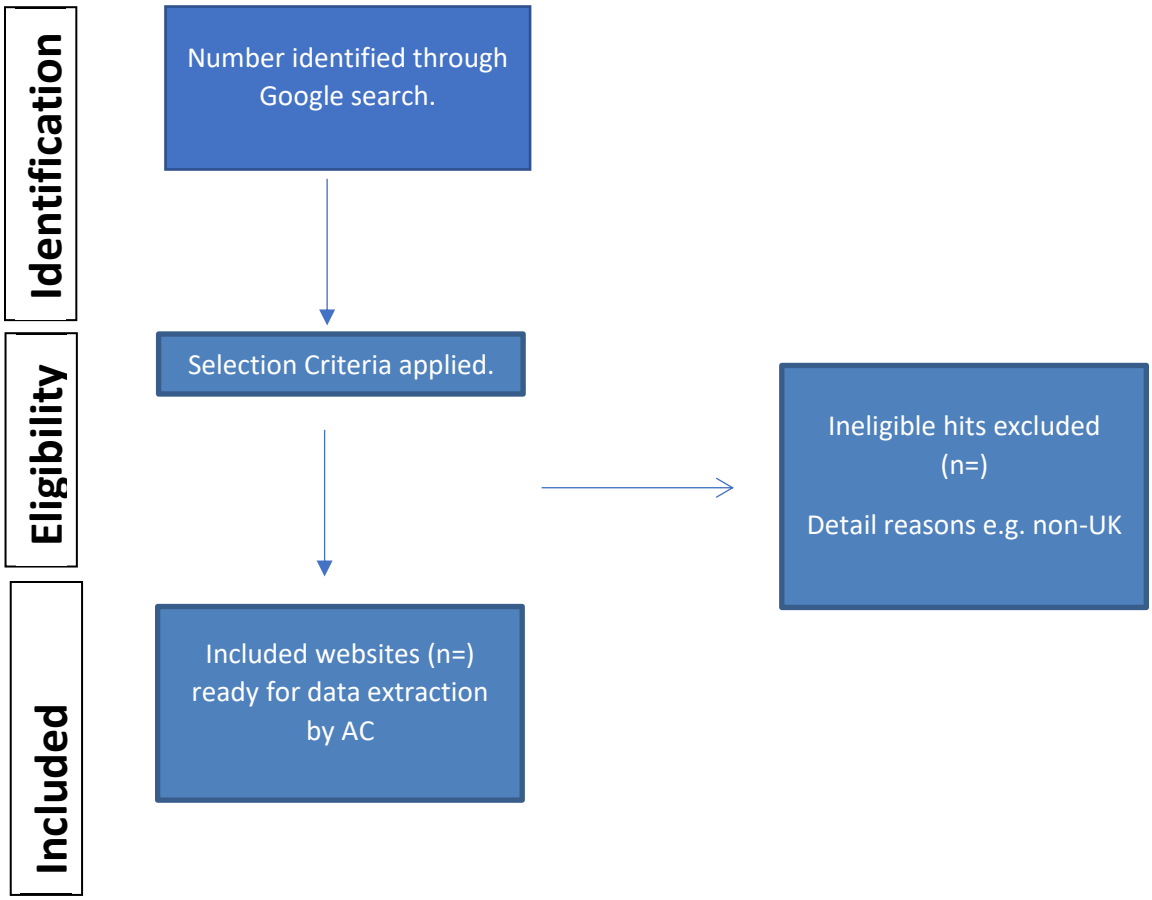
- Low back pain
- Knee pain
- Shoulder pain
- Why does my back hurt?
- Why does my knee hurt?
- Why does my shoulder hurt?

To ensure that the first 50 hits are recorded and remain constant throughout the review process, the lead author (AC) will record the website domain of each of the websites returned by the search in a Microsoft Excel (Microsoft Corp., Redmond, WA, USA) document. This will ensure that the selection criteria can be independently applied by AC and TJ without risk of the websites that are returned by the search being different.

The selection criteria will be independently applied by two members of the review team (AC and TJ) to each of the websites returned by the searches. Where there is any discrepancy, this will be resolved through discussion and a third member of the review team will arbitrate (CL) in the event of disagreement.

When viewing the websites, it is anticipated that multiple pages may need to be viewed in order to fully understand the context and obtain the information required to achieve the review objectives. As such, it is necessary to apply boundaries to the search to ensure consistency, reproducibility and rigour. Within each website, a hyperlink (a link to a webpage in another location) or Portable Document Folder (PDF) that led to information hosted within the same website will be explored and included within the data extraction and analysis. A hyperlink which leads to information hosted within an external website will not be explored or included within the data extraction and analysis. If multiple pages are viewed, or hyperlinks/PDFs explored within the same website this will represent one ‘hit’ rather than multiple ‘hits’ in the context of the first 50 hits being reviewed.

Figure 1. Flowchart of the Selection Process



Quality Appraisal

A scoping review allows for the mapping and collation of existing evidence whilst identifying gaps and informing future research. Formal appraisal of methodological quality is generally not performed in scoping reviews and is regarded as optional. However, quality appraisal will be reserved for those incidences where there are clear and significant differences in recommendations.

In such incidences, the website will be appraised by AC and TJ using the DISCERN Tool. A third member of the review team will (CL) will verify the quality appraisal.

The DISCERN Tool has been designed to help consumers of written health information to appraise the quality of the information provided without the need for specialist knowledge. Lay members were involved in the development of the tool. The tool consists of 15 questions that each relates to a separate quality criterion underpinning the readability of the information and the extent to which detail is provided. In addition to the 15 questions, there is an overall quality rating scored on a five-point Likert scale ranging from 1 (the information source is poor with extensive shortcomings) to 5 (the information has minimal shortcomings and is ‘good’ quality).

This tool has demonstrated acceptable reliability for use and has been used to appraise the quality of written health information in similar reviews of website information.

Charting the results (Data Extraction)

The relevant characteristics of the included website(s) and the key data relevant to the review objectives will be recorded in a charting table (Table 3). A separate charting table will be populated for LBP, knee and shoulder websites.

Data extraction will be independently trialled by AC and TJ on the first five included websites to assess the suitability and capacity to chart all relevant information required to answer the review objectives. If changes to the chart are deemed to be required, these will be agreed upon by AC and TJ (CL will arbitrate in the event of any disagreement) and implemented. AC and TJ will be the reviewers responsible for charting the results.

Table 3: Charting of the data from the included public-facing websites that may be used as sources of written healthcare information. A separate charting table will be produced for LBP, knee and shoulder websites.

Website Domain	Year of content creation	Year of most recent update	Target Audience i.e. public, clinicians	DISCERN Score	Key Findings that relate to the review questions (Inc. recommendations for/against diagnostic imaging and under what circumstances)
The DISCERN Tool is designed to help consumers of written health information to appraise the quality of the information provided. The tool consists of 15 questions that each relates to a separate quality criterion underpinning the readability of the information and the extent to which detail is provided. In addition to the 15 questions, there is an overall quality rating scored on a five-point Likert scale ranging from 1 (the information source is poor with extensive shortcomings) to 5 (the information has minimal shortcomings and is 'good' quality)					

Presentation of the results (Synthesis and Reporting)

The content of the included websites will determine how they are presented. It is anticipated that they will be presented with reference to their body site (Back, Knee or Shoulder pain) and content in a tabular form, as outlined in Table 3. An associated descriptive narrative that aligns the results to the review objectives will also be presented, in particular exploring areas of agreement and discrepancy across the websites and body regions.

Dissemination

The finalised manuscript of the scoping review will be written up for publication and submitted for presentation at relevant national and international conferences.

In addition to peer-reviewed publication, findings of the scoping review will be disseminated through social media in the form of an infographic intended for both professional and public audiences. The findings of the review will be made available for those who attended the PPIE meeting.

These findings from the review will be utilised to inform the development of topic guides for use within future qualitative studies. These qualitative studies will form the second phase of the PhD and consist of interviews with clinicians involved in the requesting of diagnostic imaging, and patients seeking care with LBP, knee and shoulder pain. The aim of these qualitative studies is to gain insight and understanding behind the rationale and decision making for diagnostic imaging.

Project Gantt Chart

Activity	February	March	April	May
Finalise Protocol				
Run Search, Select Studies, Data Extraction				
Data Analysis				
Write Manuscript				
Submission & dissemination				

Appendix 11: This table provides an overview of how the data was coded inductively to inform the development of themes as part of the narrative synthesis.

No.	Website Domain	Body Site	Clear and Substantial Differences (Y/N)	DISCERN Score	Target Audience i.e. public, clinicians	Key Findings that relate to the review questions (Inc. recommendations for/against diagnostic imaging and under what circumstances)	Initial Codes
1	https://www.nhs.uk/conditions/back-pain/	Low Back Pain (LBP)	No	3	Public	If you need an X-ray, it might be possible to have one at the unit, or you may be referred to hospital (Sprain or strain). If your symptoms do not get better, your GP might recommend further tests, like an MRI scan (Slipped disc). Your rheumatologist will carry out imaging tests to examine the appearance of your spine and pelvis. These may include an X-ray, a MRI scan or an ultrasound scan (Ankylosing Spondylitis). (Ankylosing Spondylitis) Spondylolisthesis can easily be confirmed by taking an X-ray of your spine from the side while you're standing. This will show whether a bone in your spine has slipped out of position or if you have a fracture. If you have pain, numbness, tingling or weakness in your legs, you may need additional tests,	Confirms diagnosis; imaging not essential; Imaging may be required; Image if expected to change management, biomedical language, reasoning, not responding to treatment.

						such as a CT scan or an MRI scan. These more detailed scans will be able to help work out whether you have a compressed nerve in your back (Spondylolisthesis). In hospital you are likely to have X-rays taken of your arms, legs, skull, spine and pelvis to look for any damage. It's likely you will also need other scans, such as CT scans and MRI scans (Multiple Myeloma). An X-ray can usually confirm the diagnosis and determine the cause of the kyphosis. Further scans are usually only required if complex treatment, such as surgery, is being planned, or if you have additional symptoms that suggest your nervous system has been affected, such as numbness in your arms or legs. If you need additional scans you'll probably have a: • computerised tomography (CT) scan – where a series of X-rays are taken to build-up a detailed 3-	

						dimensional image of your spine • magnetic resonance imaging (MRI) scan – where strong, fluctuating magnetic fields are used to produce a detailed image of the inside of your spine (Kyphosis).	

Appendix 12 - Example DISCERN Tool

Website: https://www.bupa.co.uk/health-information/knee-clinic/explore-knee-pain		
Question	**Score (1-5)**	**Comments**
1) Are the aims clear?	5	The aims of the website are clearly outlined – to provide information about knee pain, promote self-management and support decision making regarding treatment.
2) Does it achieve its aims?	5	The information provided is wide ranging and matches that you'd expect derived from the stated aims.
3) Is it relevant?	5	The information provided is detailed and wide-ranging with the language clear and easy to comprehend.
4) Is it clear what sources of information were used to compile the publication (other than the author or producer)?	4	The references are provided in a reference list at the end of the page however, no in-text citations are used.
5) Is it clear when the information use or reported in the publication was produced?	4	The references are provided in a reference list at the end of the page however, no in-text citations are used. The dates of the sources and the date that the page requires review are clearly documented.
6) Is it balanced and unbiased?	4	A wide range of treatment options and evidence are explored. The page does not appear to be independently reviewed.
7) Does it provide details of additional sources of support and information?	4	The website does provide additional sources of information, the majority within the same organisation however, the page does also link to the website of the Chartered Society of Physiotherapy.
8) Does it refer to areas of uncertainty?	5	Uncertainty is explicitly referred to with reference to risks and benefits, informed by the evidence.
9) Does it describe how each treatment works?	-	Not applicable
10) Does it describe the benefits of each treatment?	-	Not applicable
11) Does it describe the risks of each treatment?	-	Not applicable
12) Does it describe what would happen if no treatment is used?	-	Not applicable
13) Does it describe how the treatment choices affect overall quality of life?	-	Not applicable
14) Is it clear that there may be more than one possible treatment choice?	-	Not applicable
15) Does it provide support for shared decision making?	5	The information for those with knee pain includes a dedicated section on shared decision making (SDM) and

		advice on how to engage with this, including the use of decision grids.
16) Based on the answers to all of the above questions, rate the overall quality of the publication as a source of information about treatment choices	5	The average score across sections was 4.5 which has been rounded up to five. It would suggest that this source of information is a useful and appropriate source. The average score across sections was 1.8 and this has been rounded up to two. It would suggest that this source of information has serious limitations and is not a useful source.
The DISCERN Tool is designed to help consumers of written health information to appraise the quality of the information provided. The tool consists of 15 questions that each relates to a separate quality criterion underpinning the readability of the information and the extent to which detail is provided. These questions are organised into two main sections. Section 1 (Questions 1-8) relates to the reliability of the information source and whether it can be trusted. Section 2 (Questions 9-15) relates to specific details about treatment choices. In addition to the 15 questions, there is an overall quality rating scored on a five-point Likert scale ranging from 1 (the information source is poor with extensive shortcomings) to 5 (the information has minimal shortcomings and is 'good' quality).		

Appendix 13: Confirmation of Scheme B CSPCT Research Grant funding

The CSP Charitable Trust
Registered Charity No. 279882

Mr Andrew Cuff
Connect Health

25 March 2021

Dear Andrew,

PRF Reference Number: PRF/19/B05

Investigators: Andrew Cuff, Chris Littlewood, Lisa Dikomitis and Nadine Foster

Project Title: Understanding the use of diagnostic imaging in musculoskeletal pain conditions affecting the lower back, knee and shoulder: a qualitative investigation.

I am pleased to enclose the grant award letter for your research project which was approved for funding by the Chartered Society of Physiotherapy Charitable Trust (CSPCT) after consideration by its Scientific Panel. The award must be applied exclusively for the research project defined in your application. The allocation of this award between various cost headings is given in the enclosed **Appendix I: Award Information**.

A copy of this letter should be sent to your administrative and/or your financial department. Please check the details of the grant award and contact the Charitable Trust and Awards Officer at prfaward@csp.org.uk, if there are any discrepancies.

Appendix 14: Standards for reporting Qualitative Research – Checklist

Standard	Page Number
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Appendix 15 - Ethical approval documents

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

Gwasanaeth Moeseg Ymchwil
Research Ethics Service

Ariennir gan **Lywodraeth Cymru**
Funded by **Welsh Government**

Wales REC 7
E-mail : Wales.REC7@wales.nhs.uk
Website : www.hra.nhs.uk

Please note: This is the favourable opinion of the REC only and does not allow you to start your study at NHS sites in England until you receive HRA Approval

01 March 2021

Professor Chris Littlewood
Department of Health Professions
Faculty of Health, Psychology and Social Care
Brooks Building, 53 Bonsall Street
Manchester
M15 6GX

Dear Professor Littlewood

Study title:	**Understanding the use of diagnostic imaging in musculoskeletal pain conditions affecting the lower back, knee, and shoulder: a qualitative investigation.**
REC reference:	**21/WA/0061**
Protocol number:	**25489**
IRAS project ID:	**292128**

The Research Ethics Committee (REC) reviewed the above application at the meeting held on 24 February 2021. Thank you for attending to discuss the application.

The members of the Committee present gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below. .

Good practice principles and responsibilities

The UK Policy Framework for Health and Social Care Research sets out principles of good practice in the management and conduct of health and social care research. It also outlines the responsibilities of individuals and organisations, including those related to the four elements of research transparency:

1. registering research studies
2. reporting results
3. informing participants
4. sharing study data and tissue

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

NHS
Health Research Authority

Professor Chris Littlewood
Department of Health Professions
Faculty of Health, Psychology and Social Care
Brooks Building, 53 Bonsall Street
M15 6GX

Email:
HCRW.approvals@wales.nhs.uk

03 March 2021

Dear Professor Littlewood

HRA and Health and Care Research Wales (HCRW) Approval Letter

Study title:	**Understanding the use of diagnostic imaging in musculoskeletal pain conditions affecting the lower back, knee, and shoulder: a qualitative investigation.**
IRAS project ID:	**292128**
Protocol number:	**25489**
REC reference:	**21/WA/0061**
Sponsor	**Manchester Metropolitan University**

I am pleased to confirm that **HRA and Health and Care Research Wales (HCRW) Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

Please now work with participating NHS organisations to confirm capacity and capability, in line with the instructions provided in the "Information to support study set up" section towards the end of this letter.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?
HRA and HCRW Approval does not apply to NHS/HSC organisations within Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report (including this letter) have been sent to the coordinating centre of each participating nation. The relevant national coordinating function/s will contact you as appropriate.

10/03/2021

Project Title: Understanding the use of diagnostic imaging in musculoskeletal pain conditions affecting the lower back, knee and shoulder: a qualitative investigation.

EthOS Reference Number: 25489

Certification

Dear Andrew Cuff,

The above application was reviewed by the Research Ethics and Governance Team and on the 10/03/2021, was certified. The certification is in place until the end of the project and is based on the documentation submitted with your application.

Application Documents

Document Type	File Name	Date	Version
Additional Documentation	Clinician_ PIS_v1.1	03/03/2021	1.1
Additional Documentation	Consent Form_Clinicians_v1.0	03/03/2021	1.0
Additional Documentation	Consent Form_Patients_v1.0	03/03/2021	1.0
Additional Documentation	Consent to Contact Form_Clinicians_v1.0	03/03/2021	1.0
Additional Documentation	Consent to Contact Form_Patients_v1.0	03/03/2021	1.0
Additional Documentation	Patient_PIS_v1.1	03/03/2021	1.0
Additional Documentation	Understanding the use of Diagnostic Imaging - Clinician PowerPoint Intro v1.0 16 Dec 2020	03/03/2021	1.0
Additional Documentation	ACuff_Protocol Template for HRA Approval - Core Docs for HRA_v1.0 16122020	03/03/2021	1.0
Additional Documentation	IRAS 292128 (Approval)_Letter_of_HRA_Approval	03/03/2021	1.0
Additional Documentation	IRAS 292128 Acknowledgement_for_documentation_received_following_a_FO_FIFO_AC (8)	03/03/2021	1.0
Additional Documentation	21-WA-0061 IRAS 292128 Favourable opinion with additional conditions	03/03/2021	1.0

Conditions of certification

The Research Ethics and Governance Team would like to highlight the following conditions

Adherence to Manchester Metropolitan University's Policies and procedures

This certification is conditional on adherence to Manchester Metropolitan University's Policies, Procedures, guidance and Standard Operating procedures. These can be found on the Manchester Metropolitan University Research Ethics and Governance webpages.

Amendments

If you wish to make a change to this approved application, you will be required to submit an amendment in accordance with Health Research Authority guidelines. Please contact the Research Ethics and Governance team for advice around how to do this.

We wish you every success with your project.

Research Ethics and Governance Team

Appendix 16 – Permission from Connect Health to be a recruitment site.

The Light Box
Quorum Park,
Benton Lane,
Newcastle-upon-Tyne
NE12 8EU

Dear Andrew,

Thank you for your time earlier. Please accept this letter as confirmation that Connect Health services can be utilised within your planned study (**"Understanding the use of Diagnostic Imaging"**) as planned recruitment sites.

Best Wishes

Dr Marwan Al-Dawoud
Director of Clinical Delivery

Appendix 17 – Participant Information Sheet (Patient)

Participant Information Sheet (Patient)

Understanding the use of diagnostic imaging in MSK pain conditions

1. Invitation to research

We would like to invite you to take part in our research study. My name is Andrew Cuff and I am an PhD candidate at Manchester Metropolitan University. This research is part of a PhD programme supervised by Professor Chris Littlewood and Dr Gillian Yeowell who are employed by the University. Our research project is looking into the use of x-rays and scans for people with lower back pain, knee pain and shoulder pain. As part of this project we hope to understand why x-rays and scans are requested, and how the results of the x-rays and scans are used to guide treatment. This study is funded by a Physiotherapy Research Foundation Award provided by the Chartered Society of Physiotherapy Charitable Trust (PRF/19/B05).

2. Why have I been invited?

You have been invited to participate in this research study following your recent appointment with your Physiotherapist for either lower back, knee, or shoulder pain. Within this appointment the use of an x-ray or scan had either been discussed, or you have been referred for an x-ray or scan. We have decided to focus our research on those with lower back, knee, or shoulder pain as these are the three most common areas of bone, joint or muscle pain. In the United Kingdom, the use of x-rays and scans for those presenting with lower back, knee, or shoulder pain is increasing. Despite this, recovery from lower back, knee or shoulder pain is variable.

3. Do I have to take part?

It is up to you to decide. We will describe the study and go through this information sheet. We will then ask you to sign a consent form to show you agreed to take part. In line with GDPR, you are free to withdraw from the study at any time, without giving a reason, but information already collected will be kept and included in the analysis.

4. What will I be asked to do?

You will have an opportunity to ask me any questions prior to agreeing to participate in our research study. Following this, an interview will be arranged at a mutually convenient time. These interviews will take place either by telephone or video-call based on your preference. As part of this interview, the consent form (copy enclosed within this pack) will be read out and you will be asked if you agree with each statement in order to provide consent, this will be audio-recorded. The interviews are expected to last between 40-60 minutes and will be audio-recorded. The interview audio-recording will be used to type the interviews up into written form to allow for the interview to be analysed.

After reading this information sheet, please complete the **consent to contact form** contained within this MS Forms link, or via the hard copy, if you are happy to be contacted about involvement in this research study:

https://forms.office.com/Pages/ResponsePage.aspx?id=-6PXaWJcm0enAlroLZCJd0Um83clw5ZEvTH7Q4ntobxUNVlFT0ZEUDlXRkVQTUI0TFlKSklOMFAxQy4u

I will then contact you via the details that you have provided where you will have the opportunity to ask any questions before consenting to participate.

5. Are there any risks if I participate?

There are no anticipated or expected risks to participating. Your care will not be affected by participation in this research study and you are free to withdraw from the study at any time prior to the data being analysed.

The interview is part of the research study and not related to your clinical care. If any clinical issues arise during the interview, or if you have any questions related directly to your clinical care, I will signpost you to the appropriate member of the clinical team to answer these for you.

Whilst no risks are anticipated, should you at any stage find the interview upsetting or distressing, you will be able pause the interview at any time and take a break. The interview will recommence when you are ready to do so, or the interview can be discontinued should you wish. You will also not be expected to answer every question should you not wish to.

6. Are there any advantages if I participate?

There are no direct benefits however, by participating in this research study, you will be contributing to knowledge creation within this healthcare population and potentially help improve care for people with lower back, knee, or shoulder pain. Namely, to understand why x-rays and scans are requested, and how the results of the x-rays and scans are used to guide treatment. To thank you for your involvement and time, you will be provided with a £30 Amazon voucher.

7. What will happen with the data I provide?

How will we use information about you?

We will need to use information from you for this research project. The interview will be written up by a professional transcription service whereby a contract will be in place to ensure confidentiality.

This information will include your initials, name, and contact details. The research team will use this information to do the research or to check your records to make sure that the research is being done properly.

Members of the research team who do not need to know who you are will not be able to see your name or contact details. Your data will have a code number instead.

We will keep all information about you safe and secure using either password protected electronic databases or lockable cupboards where hard copy materials are utilised.

Once we have finished the study, we will keep some of your data including the interview transcripts and personal data so we can check the results. We will write our reports in a way that no-one can work out that you took part in the study. We will only retain your personal data for as long as is necessary to achieve the research purpose.

What are your choices about how your information is used?

You can stop being part of the study at any time up until the point of data analysis, without giving a reason. Should you withdraw prior to the point of data analysis, any information we have for you will be will be stored in line with the data handling and storage procedures outlined below however, their data will not be included within the final analysis.

Where can you find out more about how your information is used?

You can find out more about how we use your information

- at www.hra.nhs.uk/information-about-patients/
- our leaflet available from www.hra.nhs.uk/patientdataandresearch
- by asking one of the research team (Prof Chris Littlewood – contact details below)
- by sending an email to **lehal@mmu.ac.uk** or
- by ringing us on +44 (0)161 247 3884

8 - What will happen to the results of the research study?

All participants will be sent a summary of the results via email when the study has ended, unless you indicate that you do not wish to receive a copy. The results will be written up for publication within a health journal and for presentation at healthcare conferences. This is to ensure that other healthcare colleagues are aware of what this research has found.

To ensure that the results are accessible to the public, the results of the study will be shared in the form of a YouTube video and infographic. These will be made available alongside a written plain English summary on a public-facing blog (website). All results will be anonymised.

9 - Who has reviewed this research project?

This research study has been reviewed and approved by multiple people. This includes:

- My PhD Supervisors (Professor Chris Littlewood and Dr Gillian Yeowell) at Manchester Metropolitan University.
- the 'Scientific Committee' as part of the Physiotherapy Research Foundation Award provided by the Chartered Society of Physiotherapy Charitable Trust (PRF/19/B05).
- Manchester Metropolitan University Sponsor Review (EthOS ID 25489)
- Health Research Authority (292128)

10 - Who do I contact if I have concerns about this study or I wish to complain?

Chief Investigator: Andrew Cuff

Consultant Physiotherapist & PhD Candidate

Faculty of Health, Psychology and Social Care

Manchester Metropolitan University

Brooks Building

53 Bonsall Street

M15 6GX

Phone: 07843 374 131

Email: andrew.cuff@stu.mmu.ac.uk

PhD Supervisor: Professor Chris Littlewood

Professor of MSK Research

Faculty of Health, Psychology and Social Care

Manchester Metropolitan University

Brooks Building

53 Bonsall Street

M15 6GX

Email: c.littlewood@mmu.ac.uk

Faculty of Health, Psychology and Social Care Ethics and Sponsor:

Dr Justine Daniels

Cavendish North Building

Cavendish Street

Manchester

M15 6BG

Phone: +44(0)161 247 2853

Email: ethics@mmu.ac.uk

If you have any concerns regarding the personal data collected from you, our Data Protection Officer can be contacted using the legal@mmu.ac.uk e-mail address, by calling 0161 247 3331 or in writing to: Data Protection Officer, Legal Services, All Saints Building, Manchester Metropolitan University, Manchester, M15 6BH. You also have a right to lodge a complaint in respect of the processing of your personal data with the Information Commissioner's Office as the supervisory authority. Please see: https://ico.org.uk/global/contact-us/

THANK YOU FOR CONSIDERING PARTICIPATING IN THIS PROJECT

Appendix 18 – Consent-to-Contact form (Patient)

Consent to Contact Form (Patient)

Understanding the use of diagnostic imaging in MSK pain conditions

	Please <u>initial</u> against each statement to confirm agreement	YES	NO
1.	I confirm that I have had the study explained to me by the clinician that saw me for my **Lower Back/Knee/Shoulder** pain.		
2	I confirm that I have received the information pack containing a copy of the consent form and information sheet about the study including the research team contact details.		
3	I confirm that I am interested in finding out more about the study with the view of participating in due course.		
4	I give permission for the researchers named in the participant information sheet to contact me about this research.		

Name:

……

Address:……

……

……..

Preferred Phone

Number:……..

Email

address:…….....

_____ _____ _____

Printed Name Date Signature

The same content of this form will be populated on to an MS Forms page when an e-information pack is provided to clinicians.

Clinician to complete Page 2

Inclusion Criteria	**Tick those that apply**
Adult patients (≥18 years)	
Presenting in NHS primary or intermediate care with non-traumatic (please tick only one of the following):	
- LBP	
- Knee Pain	
- Shoulder Pain	
The patient has (please tick only one of the following):	
- Been referred for a scan	
- Undergone a scan	
- Indicated an expectation for a scan	
Able to understand English, independently or with support from a relative.	
Able to undertake an interview by remote/virtual means (telephone/video)	

If the patient has either <u>been referred for a scan,</u> or <u>undergone a scan</u> please write the modality (X-ray/USS/MRI) here:……

Appendix 19 – Consent form (Patient)

CONSENT FORM (Patient)

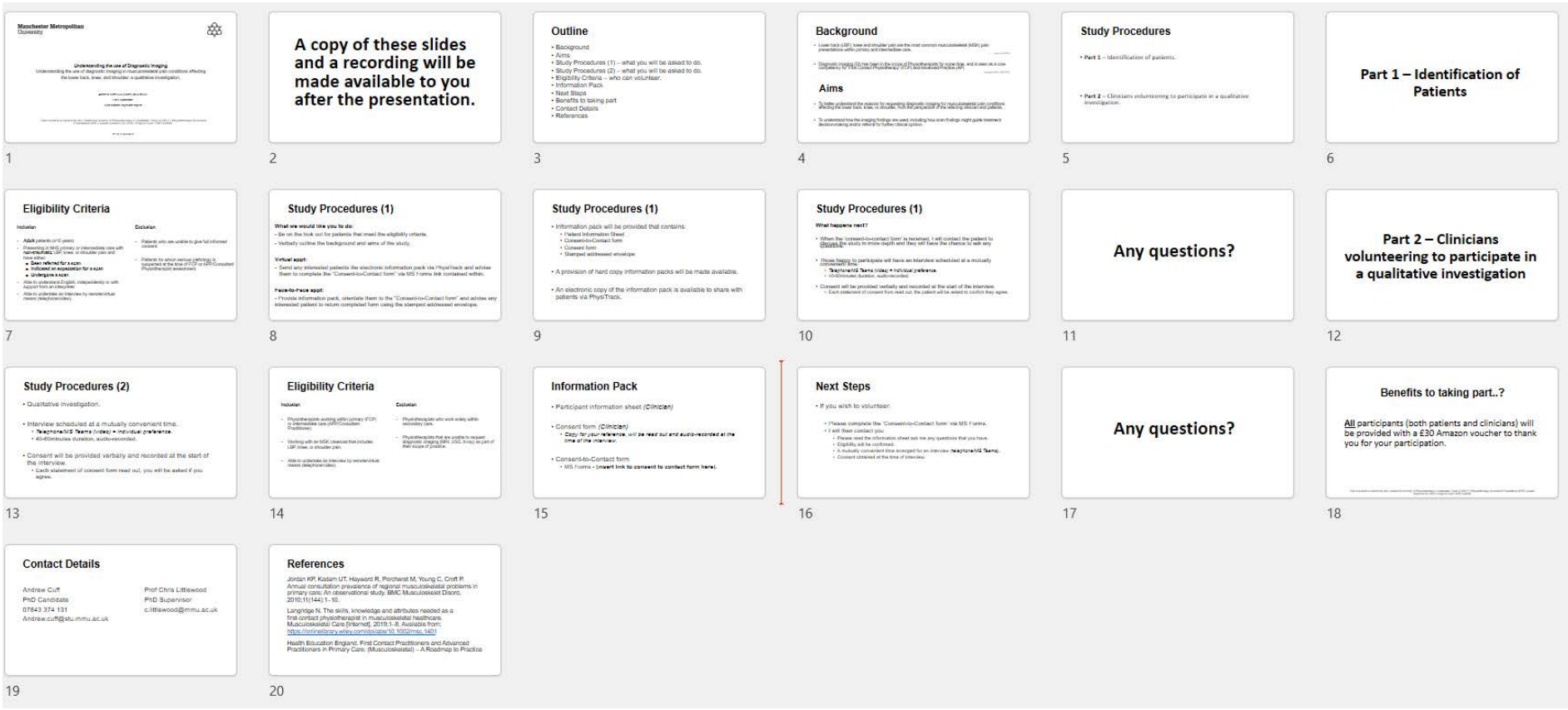
Understanding the use of diagnostic imaging in MSK pain conditions

Participant Identification Number:

	Please initial against each statement to confirm agreement	YES
1.	I confirm that I have read the participant information sheet version……., date…….for the above study.	
2	I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
3	I understand that my participation is voluntary and that I am free to withdraw at any time up until the point of data analysis without giving any reason, without my legal rights being affected.	
4	I agree to participate in the project to the extent of the activities described to me in the above participant information sheet.	
5	I agree to my participation being audio recorded for analysis. No audio clips will be published without my express consent (additional media release form).	
6	I understand and agree that my words may be quoted anonymously in research outputs.	
7	I understand that identifiable data may be viewed by the sponsor (Manchester Metropolitan University) as part of their responsibilities to monitor and audit the study.	
8	I give permission for the researchers named in the participant information sheet to contact me in the future about this research or other research opportunities.	
9	I give permission for a fully anonymised version of the data I provide to be deposited in an Open Access repository so that it can be used for future research and learning.	
10	I would like to receive by email a summary of the results of this study.	

Name of participant	Date	Signature
Name of person taking consent	Date	Signature

Appendix 20 – Study introduction presentation



Appendix 21 – Consent form (Clinician)

CONSENT FORM (Clinician)

Understanding the use of diagnostic imaging in MSK pain conditions

Participant Identification Number:

	Please initial against each statement to confirm agreement	YES
1.	I confirm that I have read the participant information sheet version……., date…….for the above study.	
2	I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
3	I understand that my participation is voluntary and that I am free to withdraw at any time up until the point of data analysis without giving any reason, without my legal rights being affected.	
4	I agree to participate in the project to the extent of the activities described to me in the above participant information sheet.	
5	I agree to my participation being audio recorded for analysis.	
6	I understand and agree that my words may be quoted anonymously in research outputs.	
7	I understand that identifiable data may be viewed by the sponsor (Manchester Metropolitan University) as part of their responsibilities to monitor and audit the study.	
8	I give permission for the researchers named in the participant information sheet to contact me in the future about this research or other research opportunities.	
9	I give permission for a fully anonymised version of the data I provide to be deposited in an Open Access repository so that it can be used for future research and learning.	
10	I would like to receive by email a summary of the results of this study.	

Name of participant	Date	Signature
Name of person taking consent	Date	Signature

Appendix 22 - Participant Information Sheet (Clinician)

Participant Information Sheet

Understanding the use of diagnostic imaging in MSK pain conditions

8. Invitation to research

We would like to invite you to take part in our research study. My name is Andrew Cuff and I am an PhD candidate at Manchester Metropolitan University. This research is part of a PhD programme supervised by Professor Chris Littlewood and Dr Gillian Yeowell who are employed by the University. Our research project is looking into the use of x-rays and scans for people with lower back pain, knee pain and shoulder pain. As part of this project we hope to understand why x-rays and scans are requested, and how the results of the x-rays and scans are used to guide treatment. This study is funded by a Physiotherapy Research Foundation Award provided by the Chartered Society of Physiotherapy Charitable Trust (PRF/19/B05).

9. Why have I been invited?

You have been invited to participate in this research study as a physiotherapist that is either working in primary care as a First Contact Physiotherapist (FCP) or working within an intermediate care MSK service as an Advanced Practice Physiotherapist (APP) or Consultant Physiotherapist. We have decided to focus our research on presentations of lower back, knee, or shoulder pain as these are the three most common areas of bone, joint or muscle pain. In the United Kingdom, the use of x-rays and scans for those presenting with lower back, knee, or shoulder pain is increasing. Despite this, recovery from lower back, knee or shoulder pain is variable.

10. Do I have to take part?

It is up to you to decide. We will describe the study and go through this information sheet. We will then ask you to sign a consent form to show you agreed to take part. In line with GDPR, you are free to withdraw from the study at any time, without giving a reason, but information already collected will be kept and included in the analysis.

11. What will I be asked to do?

You will have an opportunity to ask me any questions prior to agreeing to participate in this research study. Following this, an interview will be arranged at a mutually convenient time. These interviews will take place either by telephone or video-call based on your preference.

As part of this interview, the consent form (copy enclosed within this pack) will be read out and you will be asked if you agree with each statement in order to provide consent, this will be audio recorded. The interviews are expected to last between 40-60 minutes and will also be audio-recorded. The interview audio-recording will be used to type the interviews up into written form to allow for the interview to be analysed.

After reading this information sheet, please complete the **consent to contact form** contained within this MS Forms link if you are happy to be contacted about involvement in this research study:

https://forms.office.com/Pages/ResponsePage.aspx?id=-6PXaWJcm0enAlroLZCJd0Um83clw5ZEvTH7Q4ntobxUNjAwODU3Sjc1NUhQRVpYWExXMk40QVFSSS4u

I will then contact you via the details that you have provided where you will have the opportunity to ask any questions before consenting to participate.

12. Are there any risks if I participate?

There are no anticipated or expected risks to participating and you are free to withdraw from the study at any time prior to the data being analysed.

Whilst no risks are anticipated, should you at any stage find the interview upsetting or distressing, you will be able pause the interview at any time and take a break. The interview will recommence when you are ready to do so, or the interview can be discontinued should you wish. You will also not be expected to answer every question should you not wish to.

13. Are there any advantages if I participate?

There are no direct benefits however, by participating in this research study, you will be contributing to knowledge creation within this healthcare population and potentially help improve care for people with lower back, knee, or shoulder pain. Namely, to understand why x-rays and scans are requested, and how the results of the x-rays and scans are used to guide treatment. To thank you for your involvement and time, you will be provided with a £30 Amazon voucher.

14. What will happen with the data I provide?

How will we use information about you?

We will need to use information from you for this research project. The interview will be written up by a professional transcription service whereby a contract will be in place to ensure confidentiality.

This information will include your initials, name, and contact details. The research team will use this information to do the research or to check your records to make sure that the research is being done properly.

Members of the research team who do not need to know who you are will not be able to see your name or contact details. Your data will have a code number instead.

We will keep all information about you safe and secure using either password protected electronic databases or lockable cupboards where hard copy materials are utilised.

Once we have finished the study, we will keep some of your data including the interview transcripts and personal data so we can check the results. We will write our reports in a way that no-one can work out that you took part in the study. We will only retain your personal data for as long as is necessary to achieve the research purpose.

What are your choices about how your information is used?

You can stop being part of the study at any time up until the point of data analysis, without giving a reason. Should you withdraw prior to the point of data analysis, any information we have for you will be will be stored in line with the data handling and storage procedures outlined below however, their data will not be included within the final analysis.

Where can you find out more about how your information is used?

You can find out more about how we use your information

- at www.hra.nhs.uk/information-about-patients/
- our leaflet available from www.hra.nhs.uk/patientdataandresearch
- by asking one of the research team (Prof Chris Littlewood – contact details below)
- by sending an email to **legal@mmu.ac.uk** or
- by ringing us on +44 (0)161 247 3884

8 - What will happen to the results of the research study?

All participants will be sent a summary of the results via email when the study has ended, unless you indicate that you do not wish to receive a copy. The results will be written up for publication within a health journal and for presentation at healthcare conferences. This is to ensure that other healthcare colleagues are aware of what this research has found.

To ensure that the results are accessible to the public, the results of the study will be shared in the form of a YouTube video and infographic. These will be made available alongside a written plain English summary on a public-facing blog (website). All results will be anonymised.

9 - Who has reviewed this research project?

This research study has been reviewed and approved by multiple people. This includes:

- My PhD Supervisors (Professor Chris Littlewood and Dr Gillian Yeowell) at Manchester Metropolitan University
- the 'Scientific Committee' as part of the Physiotherapy Research Foundation Award provided by the Chartered Society of Physiotherapy Charitable Trust (PRF/19/B05).
- Manchester Metropolitan University Sponsor Review (EthOS ID 25489)
- Health Research Authority (292128)

10 - Who do I contact if I have concerns about this study or I wish to complain?

Chief Investigator: Andrew Cuff

Consultant Physiotherapist & PhD Candidate

Faculty of Health, Psychology and Social Care

Manchester Metropolitan University

Brooks Building

53 Bonsall Street

M15 6GX

Phone: 07843 374 131

Email: andrew.cuff@stu.mmu.ac.uk

PhD Supervisor: Chris Littlewood

Professor of MSK Research

Faculty of Health, Psychology and Social Care

Manchester Metropolitan University

Brooks Building

53 Bonsall Street

M15 6GX

Email: c.littlewood@mmu.ac.uk

Faculty of Health, Psychology and Social Care Ethics and Sponsor:

Dr Justine Daniels

Cavendish North Building

Cavendish Street

Manchester

M15 6BG

Phone: +44(0)161 247 2853

Email: ethics@mmu.ac.uk

If you have any concerns regarding the personal data collected from you, our Data Protection Officer can be contacted using the legal@mmu.ac.uk e-mail address, by calling 0161 247 3331 or in writing to: Data Protection Officer, Legal Services, All Saints Building, Manchester Metropolitan University, Manchester, M15 6BH. You also have a right to lodge a complaint in respect of the processing of your personal data with the Information Commissioner's Office as the supervisory authority. Please see: https://ico.org.uk/global/contact-us/

THANK YOU FOR CONSIDERING PARTICIPATING IN THIS PROJECT

Appendix 23 - Consent-to-Contact form (Clinician)

Consent to Contact Form (Clinician)

Understanding the use of diagnostic imaging in MSK pain conditions

	Please initial against each statement to confirm agreement	YES
1	I confirm that I have received the information pack containing a copy of the consent form and information sheet about the study including the research team contact details.	
2	I give permission for the researchers named in the participant information sheet to contact me about this research.	

Name:

……

Address:……

……

……..

Preferred Phone Number:……..

Email address:…….....

_____ _____ _____

Printed Name Date Signature

With the study being introduced either by live virtual presentation, or from a video recording that will be made available following the live presentation, the 'consent to contact' form will be presented in an e-format using an MS Forms page. The content of this form will be populated on to an MS Forms page as is detailed here.

Appendix 24 – Process for obtaining audio informed consent.

To obtain audio consent, the below procedure was followed:

a. Thanks given to the participant for joining and the name of the interviewing researcher, the title of the project and the date of interview were stated.

b. The participant was reminded that the conversation is being recorded and asked to confirm this was acceptable.

c. The name of the interviewee and allocated participant number/code was stated.

d. Audio consent for the research was obtained by reading the template consent form out loud. The version number and version date of the consent form was read out. There was a pause after each consent item to allow the participant to audibly confirm for the recording.

e. This process continued until all items on the consent form had been confirmed.

Appendix 25 – Initial topic guide (Patient)

Understanding the use of Diagnostic Imaging: topic guide for interviews with patients

- Welcome participant and give thanks.
- Check information sheet has been read and if there are any further questions since our original call.
- No right/wrong answers – everybody's view is different and important.
- Stress confidentiality and anonymity.

*** START RECORDING***

- **** Read out the Consent Form – pause after each statement and ask participant to verbally confirm agreement by saying 'yes'. ****

*** STOP RECORDING***

This interview should take up to 60-minutes, do you have any questions before we start?

*** START RECORDING***

1) The aim of this study is to understand the use of x-rays and scans in people with *Lower Back/Knee/Shoulder* pain, would you like to start by telling me a little more about your *Lower Back/Knee/Shoulder* pain?

Prompt: Did you see your GP/clinician straight away?

Probe: What did you expect when you saw your GP/clinician?

2) Can you tell me how your *Lower Back/Knee/Shoulder* pain was initially diagnosed?

Prompt: What were you told about your condition?

Probe: Did you receive a diagnosis? How was the diagnosis made – how did you feel about this?

3) I understand that you have *been referred for an x-ray or scan/indicated an expectation for a x-ray or scan/undergone a x-ray or scan* can you tell me how the possibility of having an investigation came up?

Prompt 1: How did you feel when this was discussed within your consultation?

Prompt 2*:* Were you provided with any information on why the x-ray/scan was being organised? **Or** Were you provided with any information on what an x-ray/scan was not going to be organised?

Probe: Who initiated the discussion? When was the possibility first introduced? Do/did you know what to expect? What did your friends/family think? Did you have any concerns?

4) Do you think everyone with *Lower Back/Knee/Shoulder* pain should have an x-ray/scan?

Prompt: What do you think having an x-ray or scan offers, beyond having a clinical assessment (telling your clinician about the symptoms with a physical assessment)?

Probe: Why do you think that? Do you see any negatives of having an x-ray/scan?

** If did not have a scan, but had an expectation**

5a) Why do you think your clinician did not organise an x-ray/scan for you?

Probe: Did the clinician explain this to you? Well enough? How might they have explained it in a way that was acceptable to you?

** Been referred, but not yet had an x-ray/scan**

5b) What do you hope having the x-ray/scan will achieve?

Probe: Did you expect to be referred for the x-ray/scan? If expecting and not scanned – how would you have felt? If not expecting – how did you feel when it was discussed? What did the clinician advise you about the x-ray/scan? Has your clinician advised on how the results might inform the subsequent treatment?

** Undergone an x-ray/scan**

5c) Can you tell be about the results of your x-ray/scan?

Prompt: Did the results of the x-ray/scan change your treatment significantly?

Prompt: Was any information provided to you following the result, that was different to the information previously provided?

Probe: What did it show? How did you feel about the results? How were the results given to you? Were the results different to what you expected? Have there been any negative aspects?

** If did not have a scan, but had an expectation**

6a) What do you feel you have lost from *not having an x-ray or scan organised* for your *Lower Back/Knee/Shoulder* pain?

Probe: Why?

** Been referred/undergone**

6b) What do you feel you have gained from *been referred for an x-ray or scan/undergone a x-ray or scan* for your *Lower Back/Knee/Shoulder* pain?

Probe: Do you think this could have been achieved without an x-ray/scan? Why? How?

That is everything that I wanted to ask you. Is there anything else that is important to you that I have not asked? Is there anything you would like to ask me?

Thank you for taking your time to have this interview. Your contribution to this research will provide great insight into understanding the use of diagnostic imaging.

*** END RECORDING***

Appendix 26 – Initial topic guide (Clinician)

Understanding the use of Diagnostic Imaging: topic guide for interviews with clinicians

- Welcome participant and give thanks.
- Check information sheet has been read and if there are any further questions since our original call.
- No right/wrong answers – everybody's view is different and important.
- Stress confidentiality and anonymity.

*** START RECORDING***

**** Read out the Consent Form – pause after each statement and ask participant to verbally confirm agreement by saying 'yes'. ****

*** STOP RECORDING***

This interview should take up to 60-minutes, do you have any questions before we start.

*** START RECORDING***

5) The aim of this study is to understand the use of x-rays and scans (USS/MRI) in people with **non-traumatic** Lower Back/Knee/Shoulder pain, how long have you had the ability to request imaging as part of your role?

Probe: What was the reason for expanding your scope of practice to include requesting imaging? Why? Why has/hasn't your use changed?

6) To what extent do you feel your care setting influences your use of imaging?

Prompt: If working in intermediate care, how do you utilise any existing imaging results that may have been organised by the GP? Positives, negatives, challenges, opportunities.

Probe: Primary care – first contact; intermediate care – referral from GP vs. referral from Tier 1 physiotherapist. Reflect on how they feel their use might differ compared to secondary care.

7) Under what circumstances would you consider organising an x-ray or a scan for someone with **non-traumatic** Lower Back/Knee/Shoulder pain?

Prompt: Does your reasoning differ between spinal and peripheral (Shoulder/Knee) presentations?

Probe: Are there circumstances where you feel imaging is essential? What? Why? Are there circumstances where you feel you must never organise imaging? What? Why?

Where does gut feeling fit in your reasoning processes?

How much of your practice involves imaging because the person is not responding to treatment? Consider 'and expected to change management'. How often the imaging result change your management?

8) To what extent do patient expectations influence whether you organise imaging, or not?

Prompt 1: What do you think about the role of shared decision making in the context of organising imaging or not? Why?

Prompt 2: Do you ever order imaging because it is a more straightforward option compared to discussing why you will not be organising imaging?

Probe: What do you think influences patient expectations? Consider family, friends, the role of the referrer. How do you feel when having a conversation with a patient that expects imaging, but you do not feel it is indicated? Possible solutions to managing appropriate expectations (patient/referrer).

5) Do you provide patients with any information prior to organising their imaging?

Prompt: Do you discuss presence of imaging findings in asymptomatic populations with patients at all?

Probe: What? How? How well is this received – what are typical responses? How might this information be better provided to patients?

6) To what extent do you feel the use of imaging influences your clinical reasoning?

Prompt: Is it common to use imaging as a form of reassurance?

Prompt: Has your use of imaging in those with Lower Back/Knee/Shoulder pain changed over this time?

Probe: Treatment plans, referral on. How do you feel when ordering imaging? Do you consider possible harmful effects of imaging within your clinical reasoning? If so, what, and why? Are there negatives to using imaging as a form of reassurance?

7) The use of imaging across primary and intermediate care in the NHS is increasing, why do you think this might be?

Prompt: Do you feel there is a conflict between clinical practice guidelines and clinical practice?

Probe: What makes you think that? Examples. Development of CPGs i.e. secondary care. Can you think of any solutions or interventions that may facilitate more appropriate use of imaging?

That is everything that I wanted to ask you. Is there anything else that is important to you that I have not asked? Is there anything you would like to ask me?

Thank you for taking your time to have this interview. Your contribution to this research will provide great insight into understanding the use of diagnostic imaging.

*** END RECORDING***

Appendix 27 – Evolved topic guide (Patient)

Understanding the use of Diagnostic Imaging: topic guide for interviews with patients

- Welcome participant and give thanks.
- Check information sheet has been read and if there are any further questions since our original call.
- No right/wrong answers – everybody's view is different and important.
- Stress confidentiality and anonymity.

*** START RECORDING***

- **** Read out the Consent Form – pause after each statement and ask participant to verbally confirm agreement by saying 'yes'. ****

*** STOP RECORDING***

This interview should take up to 60-minutes, do you have any questions before we start?

*** START RECORDING***

9) The aim of this study is to understand the use of x-rays and scans in people with *Lower Back/Knee/Shoulder* pain, would you like to start by telling me a little more about your *Lower Back/Knee/Shoulder* pain?

Prompt: Did you see your GP/clinician straight away?

Probe: What did you expect when you saw your GP/clinician?

10) Can you tell me how your *Lower Back/Knee/Shoulder* pain was initially diagnosed?

Prompt: What were you told about your condition?

Probe: Did you receive a diagnosis? How was the diagnosis made – how did you feel about this?

11) I understand that you have *been referred for an x-ray or scan/indicated an expectation for a x-ray or scan/undergone a x-ray or scan* can you tell me how the possibility of having an investigation came up?

Prompt 1: How did you feel when this was discussed within your consultation?

Prompt 2*:* Were you provided with any information on why the x-ray/scan was being organised? **Or** Were you provided with any information on what an x-ray/scan was not going to be organised?

Probe: Who initiated the discussion? When was the possibility first introduced? Do/did you know what to expect? What did your friends/family think? Did you have any concerns?

12) Do you think everyone with *Lower Back/Knee/Shoulder* pain should have an x-ray/scan?

Prompt: What do you think having an x-ray or scan offers, beyond having a clinical assessment (telling your clinician about the symptoms with a physical assessment)?

Probe: Why do you think that? Do you see any negatives of having an x-ray/scan?

** If did not have a scan, but had an expectation**

5a) Why do you think your clinician did not organise an x-ray/scan for you?

Probe: Did the clinician explain this to you? Well enough? How might they have explained it in a way that was acceptable to you?

Probe: If clinician set out an expected timeframe for recovery that they anticipate, would that be satisfactory? If not, why, if so, why?

** Been referred, but not yet had an x-ray/scan**

5b) What do you hope having the x-ray/scan will achieve?

Probe: Did you expect to be referred for the x-ray/scan? If expecting and not scanned – how would you have felt? If not expecting – how did you feel when it was discussed? What did the clinician advise you about the x-ray/scan? Has your clinician advised on how the results might inform the subsequent treatment?

** Undergone an x-ray/scan**

5c) Can you tell be about the results of your x-ray/scan?

Prompt: Did the results of the x-ray/scan change your treatment significantly?

Prompt: Was any information provided to you before/following the result, that was different to the information previously provided?

Prompt: When you scan a body part, you often see changes related to age like wrinkles or grey hair, does this surprise you?

> ***Probe:*** Did your clinician explain this to you?
>
> ***Probe:*** If we scanned a pain free joint, such as your opposite shoulder/knee (check symptom free first!), would you expect it to look pristine?
>
> ***Probe:*** Knowing that joints often show age related changes when pain free, does this highlight any problems to you regarding the use of scanning to inform diagnosis?
>
> ***Probe:*** Radiology report including epidemiology of age-related findings to aid contextualisation as a solution – builds on previous research, what do you think?

Probe: What did it show? How did you feel about the results? How were the results given to you? Were the results different to what you expected? Have there been any negative aspects?

Prompt: does seeing the image make a difference, would you know/would it matter if it wasn't 'your' scan?

** If did not have a scan, but had an expectation**

6a) What do you feel you have lost from *not having an x-ray or scan organised* for your *Lower Back/Knee/Shoulder* pain?

Probe: Why?

** Been referred/undergone**

6b) What do you feel you have gained from *been referred for an x-ray or scan/undergone a x-ray or scan* for your *Lower Back/Knee/Shoulder* pain?

Probe: Do you think this could have been achieved without an x-ray/scan? Why? How?

That is everything that I wanted to ask you. Is there anything else that is important to you that I have not asked? Is there anything you would like to ask me?

Thank you for taking your time to have this interview. Your contribution to this research will provide great insight into understanding the use of diagnostic imaging.

*** END RECORDING***

Appendix 28 – Evolved topic guide (Clinician)

Understanding the use of Diagnostic Imaging: topic guide for interviews with clinicians

- Welcome participant and give thanks.
- Check information sheet has been read and if there are any further questions since our original call.
- No right/wrong answers – everybody's view is different and important.
- Stress confidentiality and anonymity.

*** START RECORDING***

**** Read out the Consent Form – pause after each statement and ask participant to verbally confirm agreement by saying 'yes'. ****

*** STOP RECORDING***

This interview should take up to 60-minutes, do you have any questions before we start.

*** START RECORDING***

13) The aim of this study is to understand the use of x-rays and scans (USS/MRI) in people with **non-traumatic** Lower Back/Knee/Shoulder pain, how long have you had the ability to request imaging as part of your role?

Probe: What was the reason for expanding your scope of practice to include requesting imaging? Why? Why has/hasn't your use changed?

14) To what extent do you feel your care setting influences your use of imaging?

Prompt: If working in intermediate care, how do you utilise any existing imaging results that may have been organised by the GP? Positives, negatives, challenges, opportunities.

Probe: Primary care – first contact; intermediate care – referral from GP vs. referral from Tier 1 physiotherapist. Reflect on how they feel their use might differ compared to secondary care.

Probe: First contact with a health professional sets the scene (clinician and patient interviews); how important is it to have an experienced clinician as the first point of contact?

15) Under what circumstances would you consider organising an x-ray or a scan for someone with **non-traumatic** Lower Back/Knee/Shoulder pain?

Prompt: Does your reasoning differ between spinal and peripheral (Shoulder/Knee) presentations?

Probe: When looking for a surgical/injection target, does this differ between peripheral and spine? Do you investigate before every peripheral injection?

Probe: Are there circumstances where you feel imaging is essential? What? Why? Are there circumstances where you feel you must never organise imaging? What? Why?

Where does gut feeling fit in your reasoning processes?

Probe: When gut instinct is being considered, how much do you try to appease this and is this possible without imaging?

Probe: With patients becoming more complex, to what extent do you feel that there may be a discord between what you expect/have seen and what you do see, and the impact this therefore has on imaging use?

Prompt: How much of your practice involves imaging because the person is not responding to treatment? Consider 'and expected to change management'. How often the imaging result change your management?

Probe: Scanning as not responded to treatment, how comfortable are you deciding prognostically that the person isn't responding because of a psychosocial/multidimensional factors as opposed to structure, without a scan?

Prompt: Blame/just culture does this influence how you approach those patients for whom you have some concerns but cannot articulate, as to whether you scan or not?

Prompt: To what extent do you feel language barrier may influence imaging? i.e. do you feel comfortable handling risk/uncertainty through an interpreter given importance of subjective and the risk of missing something?

16) To what extent do patient expectations influence whether you organise imaging, or not?

Prompt 1: What do you think about the role of shared decision making in the context of organising imaging or not? Why?

Prompt 2: Do you ever order imaging because it is a more straightforward option compared to discussing why you will not be organising imaging?

Probe: What do you think influences patient expectations? Consider family, friends, the role of the referrer. How do you feel when having a conversation with a patient that expects imaging, but you do not feel it is indicated? Possible solutions to managing appropriate expectations (patient/referrer).

5) Do you provide patients with any information prior to organising their imaging?

Prompt: Do you discuss presence of imaging findings in asymptomatic populations with patients at all?

Probe: What? How? How well is this received – what are typical responses? How might this information be better provided to patients?

Probe: Radiology report including epidemiology of age-related finings to aid contextualisation as a solution – builds on previous research, what do you think?

Prompt: In an ideal world, would every patient be imaged and then contextualise the findings so that they are meaningful?

Probe: To what extend is time a barrier to pre-scan contextualization?

Probe: All clinicians discussed importance of setting context pre-scan, or before providing results; given patient access to medical records or shared records, how do you try and mitigate the message from future clinicians?

8) To what extent do you feel the use of imaging influences your clinical reasoning?

Prompt: Is it common to use imaging as a form of reassurance?

Prompt: Has your use of imaging in those with Lower Back/Knee/Shoulder pain changed over this time?

Probe: Treatment plans, referral on. How do you feel when ordering imaging? Do you consider possible harmful effects of imaging within your clinical reasoning? If so, what, and why? Are there negatives to using imaging as a form of reassurance?

9) The use of imaging across primary and intermediate care in the NHS is increasing, why do you think this might be?

Prompt: Do you feel there is a conflict between clinical practice guidelines and clinical practice?

Probe: What makes you think that? Examples. Development of CPGs i.e. secondary care. Can you think of any solutions or interventions that may faciliate more appropriate use of imaging?

Prompt: Radiology referrals being written to meet the criteria when the clinical picture may not, in order to obtain the scan, to what extend do you think this is because of guidance imposed, rather than co-produced/developed?

That is everything that I wanted to ask you. Is there anything else that is important to you that I have not asked? Is there anything you would like to ask me?

Thank you for taking your time to have this interview. Your contribution to this research will provide great insight into understanding the use of diagnostic imaging.

*** END RECORDING***