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Barriers and facilitators to physical activity for people with persistent musculoskeletal pain: systematic review and synthesis using the Theoretical Domains Framework

Gregory Booth,^{1,2} Danielle D’Lima,³ Anthony Gilbert,¹ James Greenwood,⁴ Nisha Sharma,⁵ Ana Howarth,² Michael Hurley,² Michael Ussher^{2,6}

¹Therapies Department, Royal National Orthopaedic Hospital NHS Trust

²Population Health Research Institute, St. George’s University of London

³Centre for Behaviour Change, Department of Clinical, Educational and Health Psychology, University College London

⁴Victor Horsley Department of Neurosurgery, University College London Hospitals NHS Foundation Trust

⁵Department of Clinical Health Psychology, Royal National Orthopaedic Hospital NHS Trust

⁶Institute of Social Marketing and Health, University of Stirling

Corresponding author:

Gregory Booth: Gregory.booth@nhs.net

ORCiDs:

Gregory Booth: 0000-0003-3332-1890

Twitter handles:

Gregory Booth: @gregorybooth

Ethical approval statement

Ethical approval was not required for this study due it being a systematic review.

Abstract:

Background

Physical activity (PA) is recommended for people with persistent musculoskeletal pain due to its benefits on symptoms, function and general health. This systematic review aimed to identify the barriers and facilitators to PA for people with persistent musculoskeletal pain and categorise these using the Theoretical Domains Framework (TDF). It also aimed to identify the prominence of each TDF domain and similarities and differences between included conditions and PA types.

Methods

Eligible studies reported barriers and/or facilitators to PA for adults with persistent musculoskeletal pain. Barriers and facilitators were coded using the TDF. Thematic analysis was then conducted within each TDF domain. TDF domains and barrier and facilitators were then compared across the different conditions and PA types.

Results

Thirty articles were included. 'Environmental context and resources', 'social influences' and 'beliefs about consequences' are the most prominent TDF domains for both barriers and facilitators, whereas 'beliefs about capabilities' and 'emotion' are prominent domains specifically for barriers and 'reinforcement' and 'behavioural regulation' for facilitators. These domains were consistent across conditions and most PA types.

Conclusions

These findings can inform future intervention development. Healthcare professionals may benefit from prioritising addressing the more prominent TDF domains to enhance patients' PA.

Key words: Physical activity; persistent musculoskeletal pain; barriers; facilitators

Introduction

Persistent musculoskeletal pain conditions such as low back pain and osteoarthritis are leading causes of disability¹ and of the need for rehabilitation globally.² Physical activity (PA) (i.e., any bodily movement produced by skeletal muscles requiring energy expenditure, for leisure, transport, or work, and including exercise³) is recommended for the management of low back pain,⁴ osteoarthritis⁵ and persistent pain.⁶ It can be effective at improving pain, physical function and quality of life,⁷⁻¹¹ and can reduce the impact of associated health problems.¹²⁻¹⁴ Persistent musculoskeletal pain often limits people's PA levels,^{15,16} especially among those with higher disability and multiple sites of peripheral joint pain.^{17,18}

Current PA interventions for people with persistent musculoskeletal pain have a small effect on post-intervention PA levels but no long-term effect.¹⁹ Increased knowledge of PA barriers and facilitators will enable development of more effective interventions and may enhance the delivery of clinical care.

The Theoretical Domains Framework (TDF) defines 14 domains for categorising barriers and facilitators to behaviour change.²⁰ It has been used in systematic reviews as a coding framework for barriers and facilitators.^{21,22} It comprehensively covers influences on behaviour and maps to the Capability, Opportunity, Motivation-Behaviour (COM-B) model,²³ which explains how capability, opportunity and motivation interact to generate behaviour. By mapping the TDF to COM-B, it is possible to explain how TDF domains may interact to influence behaviour. This mapping also allows identification of potential behaviour change techniques (BCTs)²⁴ for informing interventions.²⁰

A previous systematic review of PA for people with low back pain highlighted a paucity of evidence on barriers and facilitators.²⁵ A later systematic review identified barriers and facilitators to PA for those with hip and knee osteoarthritis, categorised as physical (e.g., pain), intrapersonal (e.g., beliefs) and socio-environmental factors (e.g., social support).²⁶ A scoping review, using the TDF to categorise barriers and facilitators to exercise for people with hip and knee osteoarthritis, highlighted 'environmental context and resources', 'beliefs about capabilities', 'beliefs about consequences' and 'reinforcement' as prominent.²⁷ Scoping reviews lack the methodological rigour of a systematic review.

Whilst acknowledging these reviews, focusing on single conditions, there are similarities between these conditions and other musculoskeletal pain conditions, and many people have multiple conditions or pain-sites. Therefore, barriers and facilitators may be relevant for different conditions and it would be useful to examine this, whilst also identifying differences across these conditions. All types of PA are promoted in clinical practice as the type depends on patient preference and need. It would be advantageous to synthesise barriers and facilitators for all types of PA and identify differences and similarities between them. No systematic review has synthesised and compared barriers and facilitators across different conditions and PA types.

This systematic review aimed to identify barriers and facilitators to PA in people with persistent musculoskeletal pain, categorising these using the TDF. Secondary aims were to identify the prominence of TDF domains and identify any potential differences and similarities across conditions and PA types.

Methods

This systematic review (PROSPERO: CRD42021296128) is reported consistent with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement²⁸ (see supplement).

Search strategy

Search terms relevant to persistent musculoskeletal pain in the spine or peripheral joints, PA and barriers and facilitators were derived by reviewing literature, including search strategies of similar reviews, as agreed by all authors. Four databases (MEDLINE, CINAHL, PsycINFO, AMED) were searched from inception until December 10, 2021 (see supplement for search strategy). Reference lists of similar reviews were also searched.

Selection of studies

Screening

Search results were exported into Endnote²⁹ and duplicates removed. Remaining results were imported into Rayyan QCRI³⁰ for title and abstract screening. One author (GB) screened titles and abstracts for eligibility. AH and AG independently screened 50% each of titles and abstracts. Conflicts were resolved by discussion. Full texts of the remaining articles were reviewed by GB. A second author (AG) screened 20% of the full-texts. Agreement between the authors was 100%.

Eligibility criteria

We included studies with any design reporting barriers and/or facilitators to PA in people with persistent musculoskeletal pain, published in peer-reviewed journals in English, excluding systematic, narrative and scoping reviews.

We included adults (≥ 18 years) with persistent musculoskeletal pain (i.e., pain lasting ≥ 3 months³¹) in the spine or peripheral joints, including single-site and multi-site pain. Studies describing rheumatological conditions (e.g., rheumatoid arthritis) were excluded as being distinct populations. When studies met these criteria and had participants with other origins of persistent pain, they were included if at least 50% of participants met our criteria.

We excluded studies investigating barriers and facilitators to bodily-site-specific (e.g., knee pain) rehabilitation exercise programmes, unless aiming to increase overall PA, as these are often short-term, and the focus of this study is PA that is intended to be enacted long-term as part of lifestyle or symptom management.

Data extraction

GB extracted data from all included studies. JG and NS each reviewed extraction for 50% of studies. Any disagreements were resolved through discussion.

Extracted data included study characteristics (e.g., PA type), participant characteristics (e.g., demographics) and reported barriers and facilitators to PA along with supporting data for these (e.g., quotes).

Quality assessment

Study quality was assessed using the Mixed Methods Appraisal Tool (MMAT)³² which assesses methodological quality of five study designs: qualitative, randomised controlled trials, non-randomised studies, quantitative descriptive, and mixed methods. GB and JG independently assessed a third of the studies, including qualitative, quantitative and mixed-methods studies, resolving disagreements and identifying assessment issues. The remaining studies were assessed by GB.

Data analysis/synthesis

Theoretical Domains Framework coding

Barriers and facilitators were coded using the TDF,²⁰ with the following method:

1. GB independently coded barriers and facilitators from two papers. AG and NS independently coded one each of these papers.
2. Step 1 authors compared coding and resolved disagreements.
3. GB coded barriers and facilitators from four further papers. AG and NS independently coded two of these each. Thus, 20% of papers were independently reviewed by two authors.
4. Step 3 authors compared coding from these papers, resolving disagreements.
5. A codebook was developed, using these six papers, and agreed by GB, DD and MU (supplement 1).
6. GB coded the remaining studies. New barriers and facilitators were reviewed by DD and added to the codebook.
7. Where barriers or facilitators were very broad and could not be accurately coded using the TDF, the barrier/facilitator was split into multiple barriers/facilitators. Re-labelling of barriers/facilitators was agreed by GB and DD (supplementary 2).
8. The number of times any barrier/facilitator was coded to each domain was counted to rank the prominence of domains.

Thematic synthesis

We performed inductive thematic analysis within each TDF domain to generate barrier and facilitator themes that explain their content. This was done by grouping similar barriers and facilitators into clusters within each domain and then assigning each cluster a label. An explanation of each theme was developed from the extracted data fragments and by referring to the explanations/descriptions of each barrier/facilitator in the original papers. GB conducted the initial thematic analysis, which was then iteratively developed and refined following discussions amongst the authors (GB, DD and MU).

Comparing conditions and PA types

To compare differences in TDF domains and barrier and facilitator themes across conditions and PA types we categorised conditions and PA types based on similarities in the included studies. We then

identified whether the TDF domains, barrier themes and facilitator themes were present in each category, and then compared results across each condition and PA type category.

Deviations from protocol

We changed our assessment of prominence of TDF domains as we decided to exclusively use counts of the number of times a barrier and facilitator was coded to each domain and not use author statements, due to the variation and ambiguity of descriptions. We initially aimed to determine which TDF domains and barriers and facilitators were more likely to affect uptake versus maintenance of PA. However, we were unable to differentiate between uptake and maintenance as this was not reported explicitly. We also compared differences between conditions and PA types for each TDF domain and barrier and facilitator theme.

Results

Study selection

The search yielded 13,616 articles; 10,138 remained after removing duplicates, 62 remained after title/abstract screening and 32 were excluded after full-text review (see Figure 1 for PRISMA diagram and reasons for exclusion). Thirty articles were included in the systematic review.³³⁻⁶² One study was reported over two articles,^{58,59} leaving 29 studies.

Table 1 summarises the study characteristics. Twenty-one studies were qualitative, seven were quantitative and one was mixed-methods. Publication year ranged from 2006 to 2021. Studies focused on a range of physical activities (see table 1).

Participant characteristics

Participant characteristics are displayed in full in table 1. There were 1,066 participants, 62% female (28 studies reported gender). Most studies (n=22) included 100% of participants meeting our criteria. The percentage of participants meeting our inclusion in the other seven studies ranged from 60-80%. One study included both those with persistent musculoskeletal pain and physiotherapists.⁴⁹ Seventeen studies reported employment^{34-36,40,41,44,45,48,49,51,52,55-60,62}, with a mean of 53% employed. Eight studies reported co-morbidities^{35,39,40,46,48,54,59,60}, with mental health issues, respiratory conditions, cardiovascular conditions, diabetes, cancer, gastrointestinal conditions, hypothyroidism, high cholesterol and other musculoskeletal conditions reported in at least two studies. Four studies reported ethnicity, with most participants being Caucasian (range 48-100%).^{46,49,56,61} No studies reported socioeconomic status.

Quality assessment

Most studies satisfied each criterion on the MMAT, inferring good methodological quality (supplement 4). Typically, the studies provided clear research questions, using appropriate methodology, data collection and analysis. Additional appraisal, separate to the MMAT, highlighted that most of the qualitative studies presented mostly descriptive findings, offering little interpretation or theorising.

Barriers and facilitators

Twenty-seven studies reported barriers and 26 reported facilitators; 23 reported both barriers and facilitators. A total of 209 barriers and 190 facilitators were extracted. After splitting the broader barriers and facilitators into multiple barriers/facilitators, there were 213 barriers and 197 facilitators.

Conditions and physical activity types

There were three categories for conditions. These were studies that only included participants with persistent low back pain, only lower limb osteoarthritis, and a mix of conditions. The mix of conditions category includes studies that had participants with a range of conditions that met our eligibility criteria (e.g., shoulder pain, thoracic spine pain, osteoarthritis). There were four categories for PA

types. These were studies focusing on general PA, prescribed exercise, group-based exercise and aqua-based exercise.

Eight studies only included participants with persistent low back pain,^{33,34,36,47,48,53-55} 13 studies only included participants with lower limb osteoarthritis^{37,41-43,45,46,50,52,56,57,60-62} and nine studies included a mix of conditions.^{35,38-40,44,49,51,58,59} Seventeen studies focused on general PA (studies not of a specific PA type),^{33,34,36,37,41,43-45,51,54-60,62} eight focused on prescribed exercise (e.g., by a healthcare professional),^{46-50,52,53,61} three focused on group-based exercise^{35,40,42} and two on aqua-based exercise.^{38,39}

Deductive and inductive analysis

Barriers and facilitators were coded to each TDF domain, except 'optimism', which no barriers were coded to. We were unable to code 15 barriers and four facilitators due to insufficient supporting information in the papers, from five qualitative^{48,50,51,57,59} and five quantitative^{36,47,54,55,62} studies. The number of times each TDF domain was coded to, and the number of studies that contained a barrier and facilitator that was coded to each domain is displayed in table 2. Across all domains, there were 32 themes representing clusters of barriers and 27 themes representing clusters of facilitators. Full deductive and thematic analysis is displayed in table 3. Full analysis with example data is displayed in supplementary file 4.

Each TDF domain was coded in studies representing each condition category except optimism, which no studies including only participants with persistent low back pain were coded to, and goals, which no studies including mixed conditions were coded to. Each TDF domain was coded to in studies of general PA and prescribed exercise. Multiple TDF domains were not coded to in studies of group-based and aqua-based exercise. Most themes in the more prominent TDF domains described below were related to all conditions and PA types, except group-based and aqua-based exercise, which were more scarcely represented. See supplementary file 5 for full details of the relationships between barrier and facilitator themes and conditions and PA types.

Prominent TDF domains for barriers and facilitators

The five most prominent TDF domains for barriers and facilitators and the themes for each domain are presented below, ordered as per table 3. Example data relating to each theme is displayed in the full analysis in supplementary file 4.

Behavioural Regulation:

Behavioural Regulation was a prominent domain for facilitators, with two themes.

Theme: reminders and self-monitoring

Using a pedometer to monitor step count can motivate people to go walking⁶⁰ and can act as a reminder to do more PA.⁶¹ Keeping an exercise diary can facilitate PA by creating feelings of guilt if they have not done them that day.⁴⁹ Automated telephone calls to remind people about PA⁴⁶ and using a manual to remind people about specific techniques can also be helpful.⁴⁶

Theme: routine formation and planning

Developing action plans of when, how and what PA they are going to do can be a facilitator.^{46,61} Having routines can be helpful^{46,60} and can help form PA habits.⁶¹ Building specific prescribed exercises into other forms of PA (e.g. doing exercises as part of other sport) can facilitate PA⁵³ as can building PA into daily activities to ensure a purpose (such as walking to get a coffee) or when cooking.⁶¹

Social Influences

'Social influences' was a prominent domain for barriers and facilitators, with four themes representing barriers and three representing facilitators.

Barriers

Theme: social support from family, friends, peers, and colleagues

A lack of support from family, friends, colleagues and peers can be a barrier,^{34,48,54} including lack of encouragement^{42,51} or worry from family and advice to be cautious and limit activities.³⁴ The lack of somebody to do PA with can be a barrier.^{34,41,50} Specific reference was made to lack of a partner with similar fitness.⁴²

Theme: healthcare professionals

Barriers included healthcare professionals providing conflicting or incorrect advice^{50,34}, including advice not to exercise,⁴⁷ and lack of encouragement,⁴² supervision and monitoring.⁵⁰ Other barriers were perceived negative attitudes⁶¹ or disinterest⁵⁰ from healthcare professionals, as well as not finding physiotherapy sessions valuable.^{49,61}

Theme: class instructors

The approach of the class instructor, including too many exercises at too high intensity,³⁸ as well as a lack of knowledge about their condition can deter people.³⁹

Theme: self-image and other's perceptions

People with persistent musculoskeletal pain can feel embarrassed or inadequate when exercising⁶¹ due to their condition, age or weight.⁴⁴ They can also feel uncomfortable when few people look like them, especially in the gym.⁶¹

Facilitators

Theme: healthcare professional support

Facilitators are receiving recommendations, advice and instruction for PA from healthcare professionals,^{40,44,47,57,61} as well as supervision to make sure they are exercising correctly^{34,43,48,51,60}. A further facilitator is having a strong therapeutic alliance, feeling the healthcare professional is invested in them, wanting them to achieve,^{50,61} and establishing accountability as a patient does not want to let the professional down.⁶¹ Having a positive healthcare experience can also be motivating.⁶¹ Other helpful aspects are receiving personalised PA plans,^{49,61} being provided with resources to help with PA (e.g. written instructions or videos)⁴⁹ and being supported to navigate community opportunities³⁵.

Receiving ongoing follow-up from a healthcare professional with monitoring of progress can provide encouragement and reassurance.^{34,46,49,51,61}

Theme: social support from family, friends, and peers

Having PA partners^{41,46,51,58} or doing PA in groups^{34,38,48,49,57} provides social benefits.^{38,41,43} Doing PA with people with similar physical ability and/or similar conditions³⁵ can be helpful as they are more able to relate to those people which can remove stigma.⁵⁹ It also introduces other ways of coping,⁶¹ and provides motivation, inspiration, positive competition⁴² and accountability.³⁵ Having supportive family and friends that are encouraging and inspiring can facilitate PA.^{37,45,48,51,57}

Theme: community-based supervision and instruction

Having expert class instructors or gym supervisors^{46,50} in the community that are knowledgeable about chronic pain can help to modify exercises and provide people with confidence that they are exercising safely.³⁵ Instructors that make classes more fun can also be helpful.³⁸

Environmental Context and Resources

‘Environmental context and resources’ was a prominent domain for barriers and facilitators. There are five themes representing barriers and six representing facilitators.

Barriers

Theme: time

Barriers were lack of time for PA,^{47,48,53} due to competing demands,^{34,44,45,50,53,54,59-61} and prescribed exercise programmes being too long.^{49,61}

Theme: cost and finances

The cost of exercise classes,^{35,38,39} gym membership^{39,44,48,51,59} or exercise equipment can be a barrier.⁴¹ Limited finances were referenced for those unable to work or working reduced hours due to their condition,³⁵ or for those retired.^{38,39,51}

Theme: community exercise classes

Barriers include unsuitable timings of exercise classes,^{35,46} lack of classes adapted for those with persistent pain⁵¹ and for different ages,³⁹ as well as limited access to information on classes.³⁵

Theme: physical environment for PA

Facilities related barriers include equipment being difficult to use, swimming pools and surroundings being too cold,^{38,39} and long walks from car park to facilities.³⁸ Location issues include being too distant from venues^{54,55} or not being able to access them without a car and/or someone to drive them.⁴¹ Some people may lack the right equipment⁴⁸ or have an unsuitable home environment for exercises.^{49,50} Others may be affected by a lack of benches to rest when walking⁵¹ or being in hilly areas.⁶⁰ Bad weather was also a barrier to outdoor PA.^{34,44,48,50,51,54,60,61}

Theme: healthcare

Barriers were having a poor relationship with their physiotherapist⁴⁹ or feeling like the physiotherapy sessions were too short.⁶¹

Facilitators

Theme: healthcare

Facilitators were having access to healthcare professionals⁶¹, supervision and teaching on safe PA,³⁴ and follow-up contact with a healthcare professional (e.g. email, letter, telephone).³⁴

Theme: facilities

Facilitators included being able to easily access appropriate facilities,^{35,41} including being within a reachable distance^{38,43} that does not cost too much for travel, conditions of facilities such as the swimming pools being hot enough³⁸ and being able to do PA in their preferred location.^{43,49}

Theme: time

Having the time to do PA⁵⁰ and to integrate it within their lives⁶¹ and balance it with daily obligations.³⁴

Theme: community PA groups and classes

The scheduling of exercise community classes/groups can be a facilitator. Some people prefer more flexible class scheduling³⁵ and others prefer more rigid timetabling.⁴⁶ It is important that there are appropriate groups available in the community,^{57,58} such as those for people with a specific condition,⁵⁷ and that they are affordable.⁵⁸ Feeling safe during PA classes/groups can also be important.³⁵

Theme: equipment

Having appropriate equipment, such as joint supports and videos to do PA, can be a facilitator.^{34,61} Leaving equipment out, such as an exercise towel, to prompt PA, can also be a facilitator.⁴⁹

Theme: managing symptoms

Having the means to manage symptoms during PA,⁵⁸ including use of medication^{48,61} can make PA easier.

Beliefs about Capabilities

'Beliefs about capabilities' was a prominent domain for barriers, with three themes.

Theme: symptoms

Participants in several studies did not believe that they can do PA due to symptoms such as pain (in general or during PA),^{34,35,41,42} reduced range of movement or stiffness^{41,50,61}.

Theme: comorbidities

Comorbidities or sickness can lead people with persistent musculoskeletal pain to believe they cannot do PA.^{34,41,50}

Theme: lack of self-efficacy

A lack of belief in ability to do PA can be due to a general perceived lack of ability,^{50,57,61} which can be due to no prior experience³⁴ or poor past PA experiences.⁵¹ A lack of confidence in managing symptoms during PA⁴¹ or belief they cannot do as much due to older age⁴¹ are also barriers.

Beliefs about Consequences

'Beliefs about consequences' was a prominent domain for barriers and facilitators. There are two themes representing barriers and one for facilitators.

Barriers

Theme: perceived risks and harm of PA

Perceived risks and harm of doing PA can lead to fear, anxiety and subsequently, avoidance of PA.³⁶ Perceived harms include potential injury,^{33,34,45,47-49,55,59} falling,^{50,61} or worsening their condition and function^{34,38,61} and, therefore, failing to fulfil social duties, either short-term or long-term.⁴⁵ This often stems from a fear of what pain represents (e.g., harm). In other situations, the unpleasant sensation of pain and belief that PA will cause that sensation is a barrier.^{34,35,41,44,45,57,59}

Theme: lack of perceived benefits or importance

A lack of perceived benefits^{46,49} and importance of PA⁴³ can be barriers; for example, the belief that it will not help pain.^{34,35,44,60} In other situations, temporarily not having pain reduces the importance of doing PA if their aim of doing PA is symptom reduction, resulting in reduced engagement.^{48,50}

Facilitators

Theme: perceived benefits of PA

The belief that PA helps to manage pain,^{35,38,40,42,46,51,53,61} improve strength and physical function, and reduce other symptoms such as stiffness can facilitate PA.^{37,42,46,50-52,61} Believing that PA will have positive effects on quality of life,⁵⁰ including reducing social isolation³⁵ and feeling more positive can facilitate PA.³⁷ The belief that PA helps with preventing injury, recurrences of or increases in pain, and the need for future surgery can be a facilitator.^{48,50,59} Believing that PA has positive wider health benefits can also be a facilitator.^{37,47,51}

Reinforcement

'Reinforcement' was a prominent domain for facilitators, with two themes.

Theme: physical effects

Achieving positive effects on symptoms such as pain relief^{47,48,51,53,55}, reduced stiffness and fatigue, and improved balance, strength, mobility and range of movement facilitates PA by reinforcing the benefits of PA, providing incentives.^{37,40,41} Experiencing positive effects on general health can similarly facilitate PA.^{38,51}

Theme: psychosocial effects

Experiencing positive psychological effects such as improved mood,⁵⁵ reduced stress,⁴⁷ increased confidence,⁶¹ and the notion of enjoyment or pleasure^{34,43,48,50,51,61} can facilitate PA.^{34,37,41} Experiencing positive judgement about PA can lead to positive feelings,⁴⁶ and the social effects of meeting others in the community⁴⁰ can facilitate future PA. Positive emotional responses from improving management of their condition,³⁵ symptom improvement and seeing progress can facilitate PA.^{43,50,61} Anticipating feeling negative if they do not do PA,^{35,49} including feeling guilty about not doing PA that has been prescribed can also facilitate PA.⁶¹

Emotion

‘Emotion’ was a prominent domain for barriers, with three themes.

Barriers

Theme: fear/anxiety related to physical activity

There can be fear and anxiety about PA concerning injury or harm,^{33,34,36,49,61,62} falling, doing the wrong activity^{48,50} or of unpleasant experience of pain during or after PA.^{48,57} This can be due to lack of understanding or false interpretations of their condition or pain,³⁴ leading to people avoiding PA.

Theme: lack of enjoyment

Finding PA boring,^{34,51} generally not liking it^{43,55} or having comorbidities (e.g., weight gain)³⁴ can prevent people enjoying PA⁶¹.

Theme: stress and negative affect

Stress unrelated to PA, as well as finding PA stressful due to the pain during it can be a barrier.^{34,42,54,57} A person’s mental health^{35,57,59} and negative emotions can also influence PA.^{49,54} Negative feelings about their self-image related to PA, such as being unhappy with their current physical abilities⁵¹ and feeling awkward about doing PA with weight gain and older age are also factors.⁴⁴

Discussion

In this systematic review, we synthesised barriers and facilitators to PA for people with persistent musculoskeletal pain using a theoretically informed approach. The TDF domains 'environmental context and resources', 'social influences' and 'beliefs about consequences' are more prominent domains for both barriers and facilitators, whereas 'beliefs about capabilities' and 'emotion' are prominent domains specifically for barriers and 'reinforcement' and 'behavioural regulation' for facilitators. Interventions and policy that target these domains may be more likely to influence PA for this population.

Our findings are consistent with a previous systematic review of PA for people with hip and knee osteoarthritis that highlighted physical, intrapersonal/psychological and socio-environmental barriers and facilitators.²⁶ Our review has progressed these findings by identifying that psychological, social and environmental barriers/facilitators are more prominent than physical. Our findings are also consistent with a scoping review that used the TDF to categorise barriers and facilitators to exercise for people with hip and knee osteoarthritis as they also highlighted 'environmental context and resources', 'beliefs about capabilities', 'beliefs about consequences' and 'reinforcement' as prominent domains. We have built on these findings by identifying the prominence of 'social influences', 'emotion' and 'behavioural regulation'.

Our findings indicate that some factors that can be both a barrier and facilitator, depending on the individual person's context. One example is social support from family and friends or health professionals, which can be a facilitator when positive (e.g., when they provide encouragement), or a barrier if there is no social support or it is perceived as negative (e.g., telling them not to do PA). Another example is a person's beliefs about the consequences of doing PA, which can be a facilitator when positive (e.g., belief it will improve symptoms) or a barrier when negative (e.g., belief it will cause harm).

During our analysis, we identified situations where some TDF domains influenced other domains and where these interactions are supported by the COM-B model. For example, the TDF domain 'knowledge' can influence 'beliefs about consequences' and 'emotions' as a person's knowledge about their condition and the role of PA can influence their beliefs and emotions (e.g. fear) towards PA. The TDF domain 'skills' can also influence 'intentions' as having low physical capabilities to do PA can lead to a lack of desire to do it. The domain 'memory, attention and decision processes' can influence 'intentions' as fatigue can make people not want to do PA. These situations are supported by COM-B as the COM-B construct 'capability' influences 'motivation'. TDF domains 'Beliefs about consequences' and 'emotion' are closely linked as beliefs can influence emotional responses, and 'beliefs about consequences' can also influence 'intentions'. These domains are mapped to the COM-B construct 'motivation'. The TDF domain 'social influences' can also influence 'emotion' and 'intentions' as support from healthcare professionals and a strong therapeutic alliance can build accountability and the desire to do PA. Having PA partners can also increase enjoyment and motivation. Support from family and friends also influences the desire to do PA. These scenarios are also supported by COM-B, as the COM-B construct 'opportunity' influences 'motivation'. Our review demonstrates that all COM-B constructs are influential on PA in this population, but 'opportunity' and 'motivation' are more prominent than 'capability'. Our results also demonstrate how 'capability' and 'opportunity' can influence PA through 'motivation'.

Strengths, limitations and challenges

A strength of this review is the use of the TDF, a validated and extensively used theoretical framework for categorising the barriers and facilitators of behaviour. The inclusion of all study types and the involvement of multiple authors at each stage of the review enhanced rigour. This is the first review to synthesise and identify differences and similarities in barriers and facilitators to PA across different PA types and conditions. However, the majority of participants had persistent low back pain or osteoarthritis, limiting the generalisability to other conditions.

Only one study included healthcare professionals as participants⁴⁹ and multiple studies only included participants who had been or were participating in a trial of an intervention. This limits generalisability and is largely not inclusive of those who are not physically active, which likely negatively impacted the reporting of barriers. The studies lacked socioeconomic data about their participants which is important considering the environmental and social influences on PA. Our broad target behaviour and population could be considered a limitation. However, synthesising similar conditions and PA types together enables learning across these areas and has clinical relevance.

We initially aimed to identify the TDF domains and barriers and facilitators that are more important for uptake versus maintenance individually. However, we were unable to do this as studies do not consistently and explicitly differentiate between these two phases. This is important as the influences on initial change and maintenance are likely to be different and because PA interventions for this population have no long-term effect on PA levels.¹⁹ Furthermore, lapses and relapses are likely and understanding the influences on these may be helpful in prevention and recovery.

Despite this, we can theorise which TDF domains may be more important for maintenance by comparing our results to theoretical explanations of behaviour maintenance.⁶³ Sustained maintenance motives (such as enjoyment and satisfaction with outcomes), self-regulation, and environmental and social influences are considered influential on behaviour maintenance.⁶³ These correspond with the TDF domains 'emotion', 'reinforcement', 'behavioural regulation', 'environmental context and resources' and 'social influences' in our review, all of which are more prominent domains. Habits and physical and psychological resources are also considered influential on behaviour maintenance;⁶³ a specific focus on maintenance of PA may determine the relevance of these for this population.

Using the TDF to code secondary data was challenging due to limited context surrounding some barriers and facilitators and, therefore, the requirement for the author's interpretation of the data, particularly for quantitative data. This made it difficult deciding which domains to code to and sometimes coding was not possible. Labels from the original papers used for barriers and facilitators did not always appear to correspond with the data presented in the paper. Labels were sometimes vague; for example, labelling 'pain' as a barrier without a clear description of how pain was influencing PA. This made it difficult to code accurately to the TDF domains. Finally, the barriers 'physical capacity' and 'fatigue' were coded to the TDF domain 'skills'. This felt uncomfortable but was thought to be the most relevant TDF domain, perhaps reflecting a limitation of the framework. The use of multiple authors throughout the coding and development of the codebook, and long discussions between authors helped to overcome these issues.

Implications for practice and future research

PA promotion is a fundamental element of clinical practice in persistent musculoskeletal pain management to help patients manage their condition and general health. Obtaining a detailed history and understanding of each patient's situation, including physical, psychological, environmental and

social circumstances is key to providing tailored PA support. Our findings indicate that healthcare professionals should prioritise helping patients form positive beliefs about the benefits and their ability to do PA. They should explore patients' emotions around PA and help them to overcome negative feelings, such as fear. Healthcare professionals could help patients implement strategies such as self-monitoring, action planning and reminders to help them regulate their PA. Encouraging patients to reflect on positive outcomes from their PA is likely to help reinforce their future PA. Signposting to community opportunities, supplying resources (e.g., written instructions) and encouraging patients to do PA with other people are also likely to increase a patient's PA. Offering patients long-term support is likely to improve their ability to maintain PA and improve service outcomes. It is likely that individual patients will encounter multiple barriers and facilitators and therefore, tailored interventions consisting of multiple behaviour change strategies are likely to be required for each patient.

Our findings can also feed directly into logic model development and lead to identifying behaviour change techniques as part of systematic intervention development, such as when using the Behaviour Change Wheel framework.²³ Using the Behaviour Change Wheel, the TDF domains would be mapped to COM-B (as demonstrated above). The intervention types (e.g., 'enablement') and policy types (e.g., 'service provision') can then be selected, followed by selection of behaviour change techniques (e.g., 'self-monitoring of behaviour') and their modes of delivery (e.g., a mobile app). This systematic process should be guided by evidence (such as that provided by this review) and multiple stakeholder involvement and ensure relevance and applicability in real-world contexts.

We recommend future research includes more participants that are physically inactive and that have not been able to maintain PA and collect socioeconomic data about these participants. It would be beneficial to focus on healthcare professional and wider stakeholders (e.g., policy makers, public health officials) perspectives on the PA influences. Greater inclusion of those with multiple pain sites, diagnoses and comorbidities would reflect the influences on PA in those with more complexity and disability. Lastly, we recommend future research focuses specifically on maintenance of PA.

In summary, this review has identified the prominence of TDF domains for barriers and facilitators to PA for people with persistent musculoskeletal pain. These results increase the awareness of barriers and facilitators to PA for healthcare professionals and can influence future PA intervention development. Our findings also demonstrate the consistency of barriers and facilitators across persistent low back pain and osteoarthritis, and different PA types. Future research should have a specific focus on maintenance of PA and include those with greater complexity.

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G. Booth and M. Ussher conceptualised the study. All authors contributed to the design of the study. G. Booth conducted the search. G. Booth, A. Gilbert and A. Howarth completed the screening and study selection. G. Booth, N. Sharma and J. Greenwood conducted the data extraction. G. Booth and J. Greenwood assessed study quality. G. Booth, D' Lima, M. Ussher, A. Gilbert and N. Sharma contributed to the data analysis. G. Booth, D. D'Lima and M. Ussher drafted the initial manuscript which was reviewed by all other authors. All authors approved the final version of the manuscript.

Declaration of interest

The authors report no conflicts of interest.

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Table 1: Study and participant characteristics

Study (first author, year) <i>Country</i>	Study design	Participant demographics	Participant physical activity levels	Type of physical activity	Number of barriers	Number of facilitators
Ashby, 2012 <i>Australia</i>	Qualitative	Number: 11 Conditions: PLBP Age (y): mean = 42 (range 23-59) % Female: 0 % Working: 0	NR	General physical activity	2	0
Boutevillain, 2017 <i>France</i>	Qualitative	Number: 29 Conditions: PLBP Age (y): NR % Female: 35 % Working: 100	14 'active' participants	General physical activity	17	13
Dnes, 2021 <i>Canada</i>	Qualitative	Number: 15 Conditions: Arthritis, PLBP Age (y): median = 53 (range 33-81) % Female: 73 % Working: 47	4 participating in community-based exercise	Group-based exercise	6	11
Elfving, 2007 <i>Sweden</i>	Quantitative	Number: 64 Conditions: PLBP Age (y): median = 47 (range 19-64) % Female: 61 % Working: 100	32 high PA 32 low PA	General physical activity	3	0
Evans, 2016	Qualitative	Number: 7 Conditions: OA (mostly hip)	NR	General physical activity	0	7

<i>United Kingdom</i>		Age (y): median = 68 (range 65-78) % Female: 57 % Working: NR				
Fisken, 2012 <i>New Zealand</i>	Qualitative	Number: 15 Conditions: OA (mostly spine and lower limb) Age (y): mean = 72.4 (SD = 5.5) % Female: 93 % Working: NR	All participated in aqua-based exercise	Aqua-based exercise	5	7
Fisken, 2016 <i>New Zealand</i>	Qualitative	Number: 11 Conditions: OA (mostly spine and lower limb) Age (y): mean = 69.3 (SD = 4) % Female: 100 % Working: NR	All participants had discontinued aqua exercise	Aqua-based exercise	5	0
Gaskell, 2019 <i>United Kingdom</i>	Qualitative	Number: 22 Conditions: OA, PLBP, thoracic pain, neck pain, post-THR, multi-site MSK pain Age (y): mean = 57 (range 36-83) % Female: 68 % Working: 64	All participants had completed 12-week Pilates programme or over 12 months of Pilates classes	Group-based exercise	1	5
Gay, 2018 <i>France</i>	Qualitative	Number: 27 Conditions: Knee OA Age (y): mean = 67 (SD = 7.8) % Female: 63 % Working: 15	Short IPAQ: Mean = 3405 MET-min/week	General physical activity	10	8

Hammer, 2016 <i>Denmark</i>	Mixed methods	Number: 52 Conditions: Hip OA Age (y): median = 69 (IQR 65-74) % Female: 69 % Working: NR	Engagement in PA (hours/week): <2 = 3 (6%) 2-4 = 15 (29%) 4+ light PA or 2-4 vigorous PA = 33 (64%) 4+ vigorous PA = 1 (2%)	Group-based exercise	5	6
Hendry, 2006 <i>United Kingdom</i>	Qualitative	Number: 22 Conditions: Knee OA Age (y): mean = 65.3 % Female: 73 % Working: NR	6 went to the gym	General physical activity	5	6
Joelsson, 2017 <i>Sweden</i>	Qualitative	Number: 15 Conditions: Hip OA, knee OA, OA (unspecified location), PLBP, Thoracic pain Age (y): mean = 58.4 (range 35-72) % Female: 80 % Working: 33	NR	General physical activity	9	1
Kaptein, 2013 <i>Canada</i>	Qualitative	Number: 40 Conditions: OA (unspecified location) Age (y): mean = 55.8 (range 29-72) % Female: 60 % Working: 90	NR	General physical activity	6	1
Ledingham, 2020 <i>United States</i>	Qualitative	Number: 25 Conditions: Knee OA Age (y): mean = 67 (range 57-79)	Exercise adherence 4.5 (3.6) /10	Prescribed exercise	2	10

		% Female: 84 % Working: NR				
Mailloux, 2006 <i>United States</i>	Quantitative	Number: 89 Conditions: PLBP Age (y): mean = 76 (SD = 6) % Female: NR % Working: NR	49% doing weekly exercise at evaluation 72% doing weekly exercise at 2 year follow-up	Prescribed exercise	8	4
Mathy, 2015 <i>Belgium</i>	Qualitative	Number: 30 Conditions: PLBP Age (y): mean = 42 (range 22-68) % Female: 53 % Working: 87	40% doing regular PA	Prescribed exercise	15	14
Meade, 2021 <i>United Kingdom</i>	Qualitative	Number: 30 Conditions: PLBP, OA, hip pain, knee pain, ankle pain, shoulder pain Other participants: physiotherapists Age (y): mean = 44 (SD = 14) % Female: 75 % Working: 60	NR	Prescribed exercise	9	7
Moore, 2020 <i>United Kingdom</i>	Qualitative	Number: 30 Conditions: Knee OA Age (y): NR % Female: 50 % Working: NR	NR	Prescribed exercise	17	12
Petursdottir, 2010	Qualitative	Number: 12	NR	General physical activity	11	15

<i>Iceland</i>		Conditions: OA (knees, hips, spine, hands, 75% multi-site) Age (y): mean = 67 (range 50-81) % Female: 75 % Working: 25				
Quicke, 2016 <i>United Kingdom</i>	Quantitative	Number: 514 Conditions: Knee OA Age (y): mean = 62.8 (SD = 9.7) % Female: 51 % Working: 42	PASE: Baseline mean = 177 (SD = 83.3) End of trial mean = 190.5 (SD = 89.3)	Prescribed exercise	0	2
Saner, 2018 <i>Switzerland</i>	Qualitative	Number: 44 Conditions: PLBP Age (y): mean = 44.2 (SD = 13.1) % Female: 43 % Working: NR	NR	Prescribed exercise	5	4
Schaller, 2017 <i>Germany</i>	Quantitative	Number: 192 Conditions: PLBP Age (y): mean = 51.3 (SD = 7.3) % Female: 34 % Working: NR	111 (58%) inactive	General physical activity	19	0
Selby, 2019 <i>Ireland</i>	Quantitative	Number: 113 Conditions: PLBP Age (y): range <30-70+ % Female: 61 % Working: 40	39% participated in green exercise regularly	General physical activity	6	4
Soto, 2019 <i>United States</i>	Quantitative	Number: 169 Conditions: Knee OA, hip OA or knee and hip OA	Accelerometry: Mean 8.6 (SD 9.8) daily mins MVPA	General physical activity	0	1

		Age (y): mean = 65.4 (SD = 8.9) % Female: 65 % Working: 53				
Stone, 2015 <i>Canada</i>	Qualitative	Number: 15 Conditions: Knee OA, hip OA or knee and hip OA Age (y): mean = 54.6 (SD = 13.6) % Female: 60 % Working: 80	NR	General physical activity	7	4
Vader, 2020 <i>Canada</i>	Qualitative	Number: 16 Conditions: Arthritis, chronic back pain, knee pain, shoulder pain Age (y): median = 53 (range 28-87) % Female: 69 % Working: 38	NR	General physical activity	1	4
Vader, 2021 <i>Canada</i>	Qualitative	Number: 16 Conditions: Arthritis, chronic back pain, knee pain, shoulder pain Age (y): median = 53 (range 28-87) % Female: 69 % Working: 38	Median no of days participating in MVPA (self- report) = 2.5 (range 0 - 7)	General physical activity	8	2
Wallis, 2019 <i>Australia</i>	Qualitative	Number: 21 Conditions: Knee OA Age (y): mean = 67 (range 51-84) % Female: 43 % Working: 29	Fifteen patients (71%) completed at least 9 of 12 weeks of the weekly dose of 70 min	General physical activity	5	3

Willett, 2021 <i>United Kingdom</i>	Qualitative	Number: 13 Conditions: Knee OA, hip OA or knee and hip OA Age (y): mean = 63 (range 44-76) % Female: 69 % Working: NR	Mean = 2920.8 kcal/day previous 3 days (range 1975 - 4250 kcal/day)	Prescribed exercise	21	38
Zhaoyang, 2020 <i>United States</i>	Quantitative	Number: 143 Conditions: Knee OA Age (y): Mean = 65.4 (SD = 9.53) % Female: 58 % Working: 43	Mean = 70 min/day MVPA	General physical activity	1	1

Conditions: table only reports those matching our eligibility criteria

Key: IPAQ: International Physical Activity Questionnaire; IQR: interquartile range; MVPA: Moderate-vigorous physical activity; NR: not reported; OA: osteoarthritis; PASE: Physical Activity Scale for the Elderly; PLBP: persistent low back pain; SD: standard deviation; y: years;

Table 2: Theoretical Domains Framework domain counts

TDF domain	No. of times a barrier was coded to domain	No. of studies including domain (barriers)	No. of times a facilitator was coded to domain	No. of studies including domain (facilitators)
Knowledge	9	6	5	5
Skills	14	10	3	3
Social/Professional Role and Identity	2	2	7	5
Beliefs about Capabilities	18	7	5	5
Optimism	0	0	6	4
Beliefs about Consequences	34	18	23	16
Reinforcement	5	3	32	16
Intentions	16	12	5	5
Goals	2	2	8	3
Memory, Attention and Decision Processes	8	5	2	2
Environmental Context and Resources	58	23	30	13
Social Influences	28	14	67	23
Emotion	39	19	3	3
Behavioural Regulation	1	1	14	6
Shaded boxes: top 5 most prominent domains for barriers and/or facilitators that are described in main text				

Table 3: Barrier and facilitator thematic analysis for each TDF domain

COM-B construct	TDF Domain	Barrier theme(s)	Facilitator theme(s)
Capability	Knowledge	<ul style="list-style-type: none"> Condition-related Physical activity performance 	<ul style="list-style-type: none"> Understanding of the relationship between their condition and PA
	Skills	<ul style="list-style-type: none"> Symptom-related Physical fitness Other health issues 	<ul style="list-style-type: none"> Problem solving
	Memory, attention and decision processes	<ul style="list-style-type: none"> Fatigue Memory 	<ul style="list-style-type: none"> Physical and mental resources
	Behavioural Regulation	<ul style="list-style-type: none"> Lack of routine formation 	<ul style="list-style-type: none"> Reminders and self-monitoring Routine formation and planning
Opportunity	Social influences	<ul style="list-style-type: none"> Social support from family, friends, peers and colleagues Healthcare professionals Class instructors Self-image/other's perceptions 	<ul style="list-style-type: none"> Healthcare professional support Social support from family, friends and peers Community based supervision and instruction
	Environmental context and resources	<ul style="list-style-type: none"> Time Cost and finances Community exercise classes Physical environment for PA Healthcare 	<ul style="list-style-type: none"> Healthcare Facilities Time Community PA groups and classes Managing symptoms Equipment
Motivation	Social/Professional role and identity	<ul style="list-style-type: none"> Other commitments and priorities 	<ul style="list-style-type: none"> Identity as physically active person Age
	Beliefs about capabilities	<ul style="list-style-type: none"> Symptoms Comorbidities Lack of self-efficacy 	<ul style="list-style-type: none"> Higher self-efficacy
	Optimism	N/A	<ul style="list-style-type: none"> Positive mindset and attitude Desire to manage symptoms
	Beliefs about consequences	<ul style="list-style-type: none"> Perceived risks and harm of PA Lack of perceived benefits or importance 	<ul style="list-style-type: none"> Perceived benefits of PA
	Intentions	<ul style="list-style-type: none"> General lack of motivation or interest Individual circumstances Symptom-related factors 	<ul style="list-style-type: none"> Positive attitude
	Goals	<ul style="list-style-type: none"> Not prioritising PA 	<ul style="list-style-type: none"> Desire for previous level of function and PA PA behaviour goals Condition management
	Reinforcement	<ul style="list-style-type: none"> Lack of results from PA Pain aggravated by PA 	<ul style="list-style-type: none"> Physical effects Psychosocial effects
	Emotion	<ul style="list-style-type: none"> Fear/anxiety related to PA Lack of enjoyment Stress and negative affect 	<ul style="list-style-type: none"> Fear

COM-B: capability-opportunity-motivation-behaviour; PA: physical activity; TDF: Theoretical Domains Framework
Shaded boxes: top 5 most prominent domains for barriers and/or facilitators that are described in main text

