REVIEW ARTICLE

Medical Exercise Therapy for Treating Musculoskeletal Pain: A Narrative Review of Results from Randomized Controlled Trials with a Theoretical Perspective

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Abstract

Background and Purpose. The purpose of this narrative review is to present an overview and theoretical rationale of medical exercise therapy (MET) as a physiotherapeutic rehabilitation treatment for musculoskeletal pain conditions. Results from randomized controlled trials (RCTs) conducted on MET are also presented. **Methods.** Computerized searches for any RCTs were conducted on the MET concept in the databases PubMed, Medline, Embase and ISI Web of science up to 2013. **Results.** Overall findings from five included MET RCTs are long-term (≥1 year) reductions in pain and improved physical and functional capabilities. These results are interpreted in the context of the biopsychosocial model, advancing the view of a dynamic interaction among physiologic, psychological and social factors that influence pain modulation. **Discussion.** MET is a biopsychosocial treatment that reduces pain and improves activities of daily living in patients with a musculoskeletal pain condition. Pain modulation is a key feature of MET, and an important area for further research is to elucidate the specific mechanisms behind the treatment effects. Copyright © 2015 John Wiley & Sons, Ltd.

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Keywords

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Introduction

Musculoskeletal conditions are highly prevalent in western industrialized societies, and constitute the most common cause of long-term pain, physical disability and psychological conditions like anxiety and depression (Coggon *et al.*, 2013; Farioli *et al.*, 2013). In Europe, it has been estimated that up to 30% of the adult population are affected at any given time point (Woolf *et al.*, 2004). In some countries, it has been reported that musculoskeletal conditions can represent 25% of the annual cost of illness, and they represent one of the most common causes of health problems that affect the ability to sustain in work (Stewart *et al.*, 2003). About 20% of consultations in primary care settings are related to musculoskeletal conditions, and many of these patients are referred to other health professionals such as physiotherapists (Picavet and Hazes, 2003).

In the past two decades, a substantial amount of empirical evidence has accumulated demonstrating the efficacy of exercise therapy upon conditions involving musculoskeletal pain and physical disability (Smidt *et al.*, 2005). Exercise therapy involves prescription of a programme that involves voluntary muscle contractions and/or body movement with the aim of relieving symptoms or improving function. Systematic reviews and meta-analysis have shown that exercise therapy has beneficial clinical effects for most musculoskeletal conditions, suggesting that it should be a hallmark of physiotherapeutic practice (Hagen *et al.*, 2012).

Despite the consensus in the scientific literature that some form of exercise therapy is an important part of treatment for musculoskeletal conditions, there seem to be no clear guidelines on *how* the exercise should be conducted. In particular, it is important for any health professional working with exercise therapy to consider aspects of *dosage*, that is, number of repetitions and the loading of one repetition of an exercise, number of sets of repetitions of an exercise, number of exercises during a treatment, number of treatments during a week and the total number and duration of treatments (Juhl *et al.*, 2014; O'Riordan *et al.*, 2014). Other important components of an exercise therapy programme are types of physical activity, amount of muscle mass used and the intensity relative to the capability of the individual patient. It has been postulated that the relative combination and weighting of these particular elements in exercise therapy affect treatment outcomes in terms of self-reported pain levels and degree of improved function, which should have an impact on disease pathogenesis and long-term effects on disease progression (Smidt *et al.*, 2005).

Medical exercise therapy (MET) is a physiotherapeutic rehabilitation treatment with its own defined criteria and an approach with an explicit framework for grading and dosing exercises (Torstensen *et al.*, 1994; Torstensen, 1999). MET is a system of graded and progressive resistance exercises as well as moderate to high intensity aerobic exercises, in which the primary aim is to apply exercise therapy as a 'pain treatment or pain modulation' to improve subject's pain levels and improve function. The aim of this review is to introduce the specific details and background for the MET framework and review the results from conducted randomized controlled trials (RCTs). In the last part of the review, the theoretical rationale and hypothetical underlying mechanisms associated with the MET framework will be discussed, alongside suggestions for further research.

Medical exercise therapy

Background

MET was developed by the Norwegian physiotherapist Oddvar Holten during the early 1960s and has become a well-known and recognized treatment approach in the Nordic countries, in some European countries (e. g. Belgium, The Netherlands and Germany) and in parts of North America. In addition to the clinical and scientific evidence for the efficacy of MET treating musculoskeletal pain conditions, which will be outlined in the succeeding text, MET has also been shown to be a cost-effective intervention approach: high-dose MET for patients with long-standing subacromial pain can reduce costs for sick leave with 60%, compared with a 40% reduction in low-dosage exercise therapy groups. This 20% difference was estimated to reduce annual spending in Norway (with five million inhabitants) due to sick leave with $23m (Østerås *et al.*, 2008). In other words, there might be potentially large reductions in public spending on treatment of, and loss of workdays, if approaches such as MET is widely used and targeted at the highly prevalent musculoskeletal pain conditions.

Basic features of medical exercise therapy

MET is defined as a treatment approach with its own specific criteria (Torstensen *et al.*, 1994; Torstensen, 1999).

- The patient history and clinical assessment is the basis for designing an individual exercise programme.
- Specific-designed exercise equipment is used to meet the need of the patient in order to grade exercises according to their dysfunction(s), making it possible to start exercising as early as possible.
- The physiotherapist is present in the exercise room supervising, while the patient(s) is treated with graded exercise therapy.
- The therapy consists of a minimum of 1-hour active exercise therapy.
- The exercise programme/treatment is reassessed at least every third to fourth treatment.

Examination

The basis for designing a MET exercise programme is the patient's history, looking at posture, testing active and passive movements, finding what ranges of motion are comfortable pain free (or close to pain free), and specific orthopaedic and neurological tests that might highlight the patients symptoms (Torstensen *et al.*, 1994; Torstensen, 1999). From the assessments, the physiotherapist tries to elucidate what tissue structure is at fault as well as considering psychological factors like catastrophizing, fear of movement, anxiety or depression (see succeeding section on theoretical considerations for further discussion of these concepts).

Treatment

MET consists of 7–11 exercises that combine *global*, *semi-global* and *local* exercises. Global exercises involve working the whole organism dynamically, while semi-global exercising involves working an entire limb in a closed or open chain activity. Local exercises involve specifically working the affected joint, with activation of a smaller number of muscles. In the attempt to establish a close to pain-free treatment, the dosage is optimized by combining global, semi-global and local exercises. The treatment is initiated with 10–20 minutes of stationary bicycling/treadmill at a level the patient manages with a goal of ~70% of max, followed by three to four different semi-global and local exercises with three sets of 30 repetitions. After the semi-global and local exercises, the patient performs another global exercise of 5–10 minutes of stationary bicycling/treadmill. Immediately after this, another three to four semi-global and local exercises with three sets of 30 repetitions are performed. The treatment ends with another global exercise of 10 minutes of stationary bicycling/treadmill.

A MET protocol has the potential of providing more than 1,000 repetitions (for each treatment) for the body part where the patient is experiencing the pain, and probably much more than 1,000 repetitions for the whole body. The MET treatment is preferably repeated two to three times per week for at least 6 to 12 treatments. However, for some patients with long-term pain, a total number of 24–36 treatments might be needed to obtain clinical changes. For research purposes, a 12-week treatment period with three treatments a week (a total of 36 treatments) has been applied in the five different RCTs performed so far.

In MET, the global, semi-global and local exercises are of equal value, meaning that cycling for 20 minutes at some intensity activating large muscle groups distant from the painful area is just as important as exercising local muscles in the local anatomical area where the patient is experiencing the pain. For some patients, early in the treatment, global exercise(s) is performed every second exercise. This concept is used for patients that have low tolerance for exercise and especially low tolerance for local exercises performed in the anatomical area where the pain is experienced.

A typical MET exercise programme thus consists of 11 exercises where each exercise is a mirror image of the available function of the patient. MET can consist of a whole range of different starting positions using pulleys, incline boards, angle benches, multiple purpose benches, rotators, dumb bells and barbells. Furthermore, several exercises with different starting positions can be used to exercise the same body part, and methods to decrease/increase the loading can be applied by gravity assisting or gravity resisting. Thus, MET can be distinguished from other types of exercise therapy interventions in the research literature, in which typically includes lower exercise dosages (repetitions), very little or no systematic aerobic exercise, as well as unclear descriptions with regard to type/amount of supervision and the participants' pain state during treatment (Liddle *et al.*, 2004; Hayden *et al.*, 2005; Liddle *et al.*, 2005; Smidt *et al.*, 2005).

Re-examination

It is of course an illusion to believe that one from the first assessment can see all different components in a patient's status clearly. Thus, the assessment continues when testing out exercises observing the patient's level of self-efficacy, motivation for exercising and level of fear-avoidance behaviour (Vlaeyen and Linton, 2000; Woby *et al.*, 2007). During the next three to six treatments, the assessment continues, with on-going communication with the patient about the exercises: what starting positions are comfortable and what range of motion and resistance is comfortable with three sets of 30 repetitions. As the treatment proceeds, the patient is taking more and more responsibility in the exercise programme, with the physiotherapist supporting the patient.

Literature search

Computerized searches for the phrase 'MET' were conducted in the databases PubMed, Medline, Embase and ISI Web of science (see Figure 1 for a flow diagram of the search process). There was no time limit, and the search included all studies published by the end of

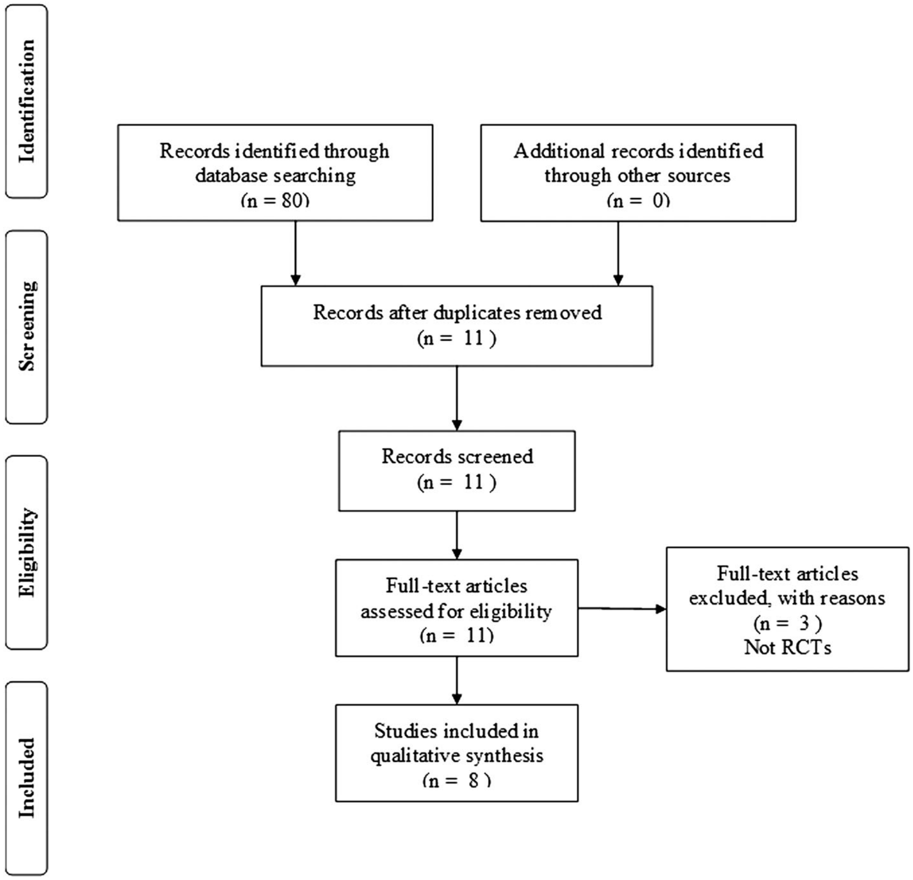

Figure 1. Overview of search process

2013. After the literature searches had been completed, all the included papers' reference lists were hand searched for additional papers. Additionally, all papers citing the included papers were identified through a search in Google Scholar. These latter procedures did not identify any additional papers. Any RCT conducted on the MET framework was included, not limiting to any specific patient groups or ages. All primary and secondary outcomes were also included.

Results

End of treatment effects and long-term follow-up after medical exercise therapy

The literature searches identified five conducted RCTs incorporating the MET framework: two trials compared high-repetitive high-dosage MET with a low-repetitive low-dosage exercise therapy programme in patients with subacromial shoulder pain (Østerås and Torstensen, 2010a; Østerås *et al.*, 2010b) and patellofemoral pain syndrome (Østerås *et al.*, 2013b; Østerås *et al.*, 2013a). One trial compared MET with treatment as usual (defined as a standardized home exercise programme) in patients that had undergone arthroscopic surgery of a degenerative meniscus (Østerås *et al.*, 2012a). Yet, another trial compared MET with conventional arthroscopic surgery in the same patient population (Østerås *et al.*, 2012c). In patients with long-term back pain with or without sciatica, MET has been compared with conventional physiotherapy or self-exercise as walking (Torstensen *et al.*, 1998). Overall, a total of 398 patients have participated in the five trials.

In all five studies, 12 weeks of MET induced significant reductions in self-reported pain levels with effect sizes ranging from 0.52 to 0.80 when compared with no treatment, low-repetitive low-dose exercise therapy or self-exercise (Table 1). In addition, MET was found to be just as efficient as arthroscopic surgery in terms of reducing pain due to degenerative meniscus (Østerås *et al.*, 2012c). Long-term follow-up of the same patient groups suggests that pain reductions are sustained in MET groups (effect sizes: 0.36–0.90) compared with other interventions/no treatment.

Table 1. Overview of results from randomized controlled trials conducted on the medical exercise therapy concept

Study	Participants	Interventions[a]	Outcomes	End of treatment	1-year follow-up
				Effect size[b]	Effect size[b]
Torstensen *et al.* (1998)	Low-back pain ($n = 208$)	E: MET or CP	Pain (VAS)	0.53	0.36
		C: self-exercise	OLBP-DQ	0.23	0.59
Østerås *et al.* (2010a, 2010b)	Subacromial	C: LD MET	Pain (VAS)	0.95	1.15[c]
	shoulder pain ($n = 61$)	E: HD MET	SRQ	1.35	1.28[c]
Østerås *et al.* (2012a, 2012b)	Arthroscopic surgery of	C: no treatment	Pain (VAS)	0.52	0.48
	degenerative meniscus ($n = 70$)	E: HD MET	KOOS	0.46	0.39
			5RM	1.25	0.85
			HAD	0.36	0.15
			One-leg hop	0.72	0.39
Østerås *et al.* (2012c)	Degenerative	C: arthroscopic surgery	Pain (VAS)	0.29	-
	meniscus ($n = 17$)	E: high-dose MET	KOOS	0.15	-
			HAD anxiety	0.19	-
			HAD depression	0.34	-
			5RM	0.23	-
Østerås *et al.* (2013a, 2013b)	Patellofemoral	C: LD MET	Pain (VAS)	0.80	0.9
	Pain syndrome ($n = 42$)	E: HD MET	Step-down test	0.81	0.6
			FIQ	0.89	0.3

[a]For additional details, see main text.

[b]Standardized mean difference, Hedges *g*.

[c]These figures are based upon 15-month follow-up.

E, experimental group; MET, medical exercise therapy; CP, conventional physiotherapy; VAS, Visual Analogue Scale; C, control group; LD MET, low-graded medical exercise therapy; HD MET, high-graded medical exercise therapy; SRQ, Shoulder Rating Questionnaire; KOOS, Knee Injury and Osteoarthritis Outcome Score; 5RM, five repetitions maximum (strength); HAD, Hospital Anxiety and Depression Scale; FIQ, Functional Index Questionnaire; OLBP-DQ, Oswestry Low Back Pain Disability Questionnaire.

Treatment effects of MET have also been assessed by various questionnaires (Knee Injury and Osteoarthritis Outcome Score, OLBP-DQ, Shoulder Rating Questionnaire and Functional Index Questionnaire) targeted at various symptoms and functions in activities of daily living. After MET interventions, patients have reported positive change of statements after end of treatment (effect size: 0.23–1.35) and at 1-year follow-up (effect size: 0.30–1.28). Results from three trials (Østerås and Torstensen, 2010a; Østerås *et al.*, 2012b; Østerås *et al.*, 2013b) indicated improved strength compared with baseline, both directly after treatment and at 1-year follow-up.

The five RCTs are pragmatic studies reflecting clinical practice on how MET and low-repetitive/low-dosage exercise therapy is used in primary health-care (physiotherapy) settings. The approach is tailored to patients with musculoskeletal pain conditions, and has insofar demonstrated its efficacy in patients with shoulder, knee and low-back conditions. Taken together, results from the current published RCTs and the theoretical basis of MET (as will be outlined in the succeeding text) with its particular focus on pain management, one might infer that other patient groups experiencing some sort of musculoskeletal pain should demonstrate positive effects of MET. Besides further studies on other patient groups, it is vital that the MET is compared with other types of multimodal interventions.

Theoretical perspectives on medical exercise therapy

General background

The theoretical basis when MET was developed during the early 1960s was the biomedical model and later the biopsychosocial model (BPS) (Torstensen *et al.*, 1994; Torstensen, 1999). The BPS model advances the view that biological, psychological and social factors all play a significant role in the context of treating conditions involving musculoskeletal pain. In general, the BPS model is postulated to be the most widely accepted and most heuristic perspective to the understanding and treatment of any condition that involves chronic pain (Gatchel *et al.*, 2007). The BPS model presumes that it is important to handle all three aspects together as a growing body of empirical literature suggesting that patient's perceptions of health and threat of disease, as well as barriers in a patient's social or cultural environment, appear to influence the likelihood that a patient will engage in health-promoting or treatment behaviours (McGeary *et al.*, 2006; Porter-Moffitt *et al.*, 2006). Consequently, the BPS model focuses on both *disease* and *illness*, with the former defined as an objective biological event involving the disruption of specific body structures or organ systems caused by anatomical, pathological or physiological changes. The latter term refers to a subjective experience or self-attribution that a disease is present (Engel, 1977; Gatchel *et al.*, 2007).

The cornerstone of high-repetitive, high-dosage MET is to decrease the subject's pain experience while at the same time improving impaired functions, enhancing a positive coping strategy and increasing the level of self-efficacy. To meet these goals using exercise therapy, specially designed equipment is used for grading exercises and making it possible to exercise pain free or close to a pain free within comfortable range of motions. To decrease sensitization of the central nervous system, it is considered important to grade the exercises pain free or close to pain free. The background for this approach is illustrated in Figure 2. The left-hand side of the figure illustrates the long-term exposure of pain mechanisms due to morphological changes. These processes interact with psychosocial mechanisms illustrated in the right-hand side of Figure 2, which together describe the total biopsychosocial function (Gatchel *et al.*, 2007) of an individual with a musculoskeletal pain condition. Before proceeding to the specifics of the theoretical rationale and possible mechanisms behind MET treatment effects, it is important for the reader to acknowledge that the mechanisms supporting the effectiveness of exercise therapy *in general* are not well-studied and understood (Hagen *et al.*, 2012). Further research in this area is highly requested to better understand the positive effects of MET.

Biological aspects of the medical exercise therapy approach

It is well-known that increased pain threshold can be experienced during and immediately after exercise. This response, termed *endogenous analgesia*, is due to the release of endogenous opioids and activation of (supra) spinal nociceptive inhibitory mechanisms orchestrated by the brain (Fuentes *et al.*, 2011). Exercise triggers the release of pain-relieving substances (e.g. endorphins) from the pituitary (peripherally) and the hypothalamus (centrally), which in turn enables analgesic effects by activating opioid receptors peripherally and centrally, respectively (Boecker *et al.*, 2008). These mechanisms might be related to cardiovascular changes (i.e. increase in heart rate and blood pressure) during exercise, which subsequently results in increased blood circulation in the brain further stimulating brain centres involved in pain

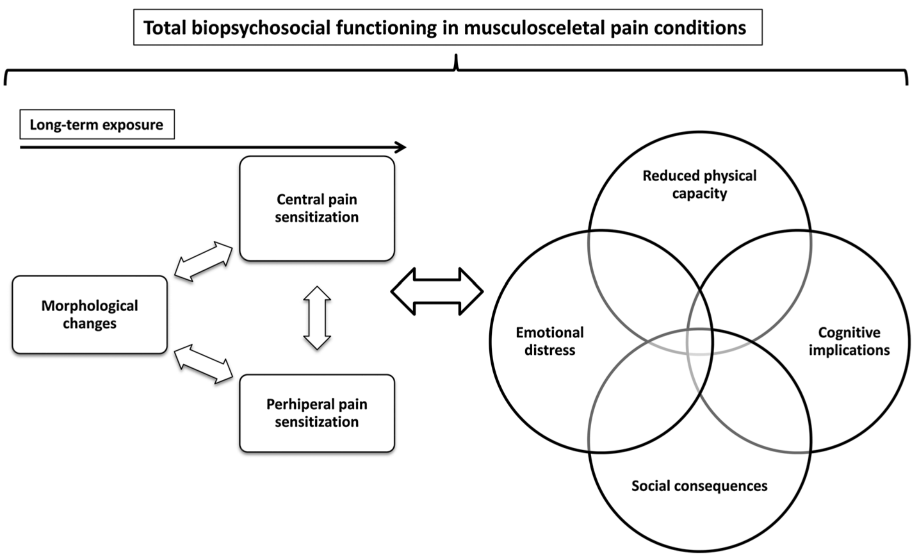

Figure 2. Schematic overview of components in the biopsychosocial model

modulation (Fuentes *et al.*, 2011). The global exercises in the MET approach have the potential to activate endogenous analgesia, resulting in generalized pain tolerance during the local/semi-global exercises. The global exercises are repeated in order to sustain these relatively short-lived pain-relieving reactions. Furthermore, varying exercise intensity, different types of contractions and recruitment of different muscle groups might also facilitate the release of different pain-reliving substances. Altogether, these findings highlight the importance of including global/semi-global exercises, as found in the MET approach, in order to trigger pain-relieving mechanisms in patients with musculoskeletal pain conditions.

Psychosocial aspects of the medical exercise therapy approach

Historically, pain has been viewed as a symptom secondary to the presence of tissue pathology and, thus, being of secondary importance. Pain is ultimately a subjective, private experience, but it can be described in terms of sensory and affective (emotional) properties. As defined by the International Association for the Study of pain, [pain] *is unquestionably a sensation in a part or parts of the body but it is also always unpleasant and therefore also an emotional experience* (Merskey and Bogduk, 2011). It is well-documented that sensory and affective components of pain interact (Seminowicz and Davis, 2006), as highlighted by the BPS model (Figure 1).

The affective component of pain incorporates many different emotions, but they are primarily negative. Of these, depression and anxiety have received considerable interest in treatment of patients with musculoskeletal pain conditions (Dersh *et al.*, 2002; Porter-Moffitt *et al.*, 2006). It is important to be aware of the significant role of these negative moods in these patient groups, because it is plausible that they influence motivation for participating in exercise therapy and compliance with exercise protocols. This, in turn, ultimately impacts upon treatment outcomes (McGeary *et al.*, 2006).

There is good evidence that the symptoms of depression decrease with an appropriate dosage of endurance exercise therapy (Brown *et al.*, 2005). There is a dose–response effect, with higher exercise dosages being more effective in decreasing depression (Dunn *et al.*, 2005). This could be one explanation why high-repetitive, high-dosage MET is effective in decreasing anxiety and depression, which might be important mediators in pain reduction. Indeed, when patients have been subjected to the Hospital Anxiety and Depression Scale before and after MET interventions, significant changes in statements have been found alongside reduction in pain ratings (Østerås *et al.*, 2012a; Østerås *et al.*, 2012b; Østerås *et al.*, 2012c). An important avenue for further research is to systematically investigate these (and other) potential mediator effects in the course of a MET intervention, not just the pre-effects versus post-effects.

As pointed out in the last section, pain sensations and emotions are closely coupled. This in turn can interact with cognitive appraisal or perception of pain. Cognitive factors that can be of vital importance in outcome of exercise therapy for musculoskeletal pain conditions include pain *appraisal* and *beliefs*, *catastrophizing* and *fear-avoidance beliefs*, as well as *perceived control* and *self-efficacy* (Vlaeyen and Linton, 2000; Woby *et al.*, 2007; Schutze *et al.*, 2010). Together, these psychological constructs resemble the individual patient's meanings and assumptions ascribed towards pain, negative orientations or expectancies towards pain or anticipated pain experiences, as well as beliefs about one's own influence on duration, frequency and intensity of the pain state (Gatchel *et al.*, 2007).

Because pain and emotions are closely coupled, a fundamental concept of MET is that the patient together with the physiotherapist decides the dosage of the exercises. Through the specific test methodology, the patient is involved in deciding the range of motion, and resistance (dosage) of each exercise. The ultimate goal is three sets of 30 repetitions. When the patient is in control of the situation, a fear of increased pain exercising should theoretically be minimized (George *et al.*, 2007; Bishop *et al.*, 2011). Moving/exercising and experiencing pain are very existential. When the patient experiences that the MET graded exercise programme in fact results in a decrease in the pain experience, one might expect that negative emotions connected to pain also decrease (Klaber Moffett *et al.*, 2004; George *et al.*, 2005). The end result is therefore a mixture of changed pain perceptions and pain levels, which potentially generate a positive cycle that ultimately might contribute to high compliance with the MET programme and further positive treatment outcomes as found from the 12-month follow-up in the clinical studies.

Summary and implications for physiotherapy practice

MET is a biopsychosocial treatment of musculoskeletal pain conditions. It is built on the view that individual status and treatment effects are the results of the dynamic interaction among physiologic, psychological and social factors. In the treatment of patients with a pain condition, pain modulation is a key feature of the MET framework, and results from five different RCTs have shown significant pain reductions in various patient groups with musculoskeletal pain conditions when compared with lower exercise dosages or treatment as usual. Furthermore, similar pain reduction effects as conventional surgery have also been found. MET has also shown to improve physical measures. After MET, patients also report improved symptom levels and functional activities of daily living on various condition-specific questionnaires. There are also some indications of reduced level of negative emotions. Importantly, end of treatment results after 12 weeks of MET are still present at long-term follow-ups (12 months). The specific mechanisms behind the effects of MET are still at the theoretical level, but related to the vast knowledge from effects of exercise on different bodily systems and functions. These effects should be understood on the basis of the BPS integrating how different psychosocial factors are affected by MET. Further research with this explicit focus, as well as further RCTs, are currently being conducted by the authors. Hopefully, this and other work might contribute to develop MET into a significant component in physiotherapeutic practice treating musculoskeletal pain.

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