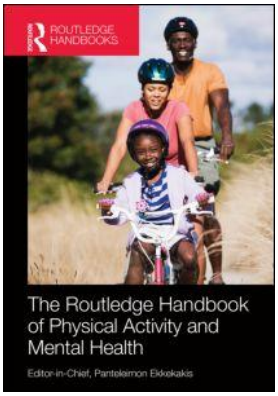

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EFFECTS OF ACUTE AND CHRONIC PHYSICAL ACTIVITY ON CHRONIC PAIN CONDITIONS

Aaron J. Stegner, Morgan R. Shields, Jacob D. Meyer, and Dane B. Cook

Patients with chronic pain are more likely to be sedentary and less likely to engage in regular physical activity or exercise than their healthy peers. Although individuals with chronic pain report many of the same obstacles to physical activity as healthy people, they also often attribute their lack of activity to disability or pain as a result of their condition and a fear of exacerbating symptoms. This perspective could be particularly detrimental for these individuals as their low levels of activity and large amounts of sedentary time put them at a greater risk for worsening their disability (McCracken & Samuel, 2007), as well as other medical conditions such as heart disease, cancer, and stroke. This process has been characterized by some as a vicious cycle; these patients are inactive, at least in part, as a result of their pain condition, which leads to greater disability, which in turn decreases the likelihood of them being physically active (Leeuw et al., 2007). The relatively low level of activity in these patients is especially troubling when considering the large and growing body of evidence demonstrating that exercise and increased levels of daily physical activity can provide benefits to individuals with chronic pain beyond enhanced physical fitness. The benefits of regular exercise for these patients may include improvements in pain symptoms, physical and functional capacity, fatigue, anxiety, depressed mood, and quality of life. For low to moderate intensity prescriptions, the consensus appears to be that chronic pain patients can engage in exercise safely and without fear of exacerbating symptoms. Clinicians, for the most part, no longer subscribe to the view that rest and activity avoidance are the best methods of managing chronic pain symptoms. In fact, following decades of research, a recommendation for exercise or increased physical activity has become a standard element of multicomponent therapies for all manner of chronic pain conditions (Iversen, 2012).

This chapter reviews the evidence for the influence of exercise and physical activity on symptoms associated with a number of chronic pain conditions including widespread musculoskeletal pain (e.g., fibromyalgia), rheumatoid arthritis, osteoarthritis, low back pain, headache, and neck pain. When possible the immediate effects of acute exercise for pain patients as well as the long-term impact of more chronic changes in physical activity levels are discussed. Where they exist, published guidelines for exercise prescription for patients with particular conditions are also reviewed. The conditions covered were chosen due to their relatively high prevalence in the U.S. population and the extent of the body of research exploring the relationship between each condition and physical activity.

Chronic widespread musculoskeletal pain

Chronic widespread musculoskeletal pain (CMP) is defined as pain occurring axially, on both the right and left side of the body and in both the upper and lower body lasting for at least 3 months (Wolfe et al., 1990). In addition, the all-over body pain cannot be explained by other pathologically defined medical conditions (e.g., arthritis, lupus, etc.). Estimates for the prevalence of CMP indicate that approximately 4% of the population is affected (Hardt, Jacobsen, Goldberg, Nickel, & Buchwald, 2008; Lindell, Bergman, Petersson, Jacobsson, & Herrstrom, 2000). Although CMP is the hallmark of fibromyalgia (FM), it is also often reported by patients being treated for Gulf War illness, irritable bowel syndrome, chronic fatigue syndrome, or depression. Not incidentally, the conditions listed above often co-occur in the same patients (Clauw, 2009).

Exercise and chronic widespread musculoskeletal pain

The large majority of what we know about the relationship between physical activity and CMP comes from research with FM patients, but other populations have been studied (e.g., Gulf War veterans, patients with irritable bowel syndrome, etc.). In just the last 5 years (2007–2012), more than 30 randomized control trials and 12 systematic reviews have been published examining the efficacy of exercise as a therapeutic treatment for FM. The interaction of acute and chronic exercise and their impact on FM symptoms is complicated. Patients with CMP report exercise, even when relativized for the participant's fitness, to be more painful and effortful than their healthy peers (Cook, Stegner, & Ellingson, 2010; Cook et al., 2012; Kadetoff & Kosek, 2010; Mengshoel, Vøllestad, & Førre, 1995). Although common perception among FM patients and many clinicians is that acute exercise leads to a worsening of symptoms, research on this topic is equivocal. Similarly, findings from research exploring increased sensitivity in patients with CMP following exercise have also been inconsistent. Despite the apparent confusion over the responses to acute bouts of exercise in CMP patients, there is now a large body of evidence suggesting that regular physical activity can positively impact many of the complaints and concomitant issues related to CMP (Busch et al., 2011).

Although patients with FM tend to be more sedentary (McLoughlin, Colbert, Stegner, & Cook, 2011) and less aerobically fit compared to sex- and age-matched controls, changes in cardiovascular fitness as a result of regular exercise do not appear to differ from those observed in healthy, formerly sedentary exercisers (Valim et al., 2003). In other words, there is no evidence to suggest that aerobic training has a differential impact on the cardiovascular fitness of patients suffering from CMP compared to healthy sedentary controls. A wide range of outcomes have been examined in order to evaluate the benefits of aerobic exercise in CMP patients, with improvements in quality of life (Brosseau et al., 2008a), decreased interference of activities of daily living (Busch, Barber, Overend, Peloso, & Schachter, 2007), and greater physical function/capacity (Busch et al., 2007; Thomas & Blotman, 2010) being among the most consistent findings. Authors of more recent reviews, perhaps due to an increase in the quality of exercise studies in FM, are more confident in their conclusions that pain, fatigue, and depressive symptoms in CMP are also positively influenced by aerobic exercise (Busch et al., 2011; Häuser et al., 2010).

The success of aerobic exercise interventions with other patient groups frequently reporting CMP is less clear as these populations have been understudied in this context. The lone randomized controlled trial on the influence of an aerobic exercise program as a treatment for veterans suffering from Gulf War illness was conducted by Donta and colleagues (2003). The results of this large-scale (N=1092), 12-week training study suggested a small effect for exercise on fatigue, cognitive symptoms, and mental health with no improvement for pain. The

conclusions of this study, however, should be interpreted with caution as the investigation suffered from poor adherence to the prescribed exercise. Likewise, a single aerobic exercise trial was conducted with patients diagnosed with irritable bowel syndrome (Daley et al., 2008). Although the patients completing this 12-week training study reported an improvement in feelings of constipation there was no significant change in symptom-related pain ratings.

In addition to muscle pain, CMP patients often report muscle fatigue and weakness. As such, resistance training may also be beneficial for patients. Similar to the changes in fitness resulting from aerobic interventions, it appears that the trainability of the neuromuscular system in patients with FM does not differ significantly from their healthy counterparts (Häkkinen, Häkkinen, Hannonen, & Alen, 2001; Valkeinen et al., 2004). Resistance training interventions with FM patients have demonstrated benefits for muscular strength and endurance without an acute increase in pain (Brossaeu et al., 2008b; Cazzola et al., 2010). Although research on this exercise modality lags in quantity behind aerobic exercise, there is evidence to suggest resistance training can be valuable for improving pain, mood, and quality of life in CMP patients (Brosseau et al., 2008b; Cazzola et al., 2010).

A number of health and wellness organizations (e.g., American College of Sports Medicine [ACSM], Centers for Disease Control, American Heart Association, American College of Rheumatology [ACR]) have made recommendations for physical activity by encouraging healthy individuals to incorporate both aerobic and strength training as part of their fitness routine. A head-to-head comparison of aerobic and strength training interventions in FM was undertaken by Bircan, Karasel, Akgun, El, and Alper (2008). The results from the study demonstrated similar improvements for both aerobic and strength training interventions in pain, sleep, fatigue, and depression. Rooks and colleagues (2007) evaluated the efficacy of three multifaceted exercise programs: (1) aerobic and flexibility training, (2) aerobic, flexibility, and strength training, and (3) aerobic, flexibility, and strength training in combination with an FM education program, in comparison to the education program alone. Improvements in physical function, FM impact, and pain were found for all exercise interventions, with no improvements for the patients receiving education alone.

In addition to traditional exercise programs, alternative therapies of which exercise is a component are also being explored. A number of studies have explored the potential for conducting exercise in warm-water pools, or aquatic exercise therapy, as a way to possibly combine the purported benefits of balneotherapy, or warm-water therapy, with exercise. Limited evidence shows aquatic exercise therapy to be at least as effective as land-based exercise in providing pain relief, but may be superior in regard to improved mood (Cazzola et al., 2010; Gowans & deHueck, 2007). Mind-body exercise approaches, such as tai chi, qigong, and yoga, are also gaining notoriety as potentially efficacious interventions for CMP and appear to offer similar benefits for pain symptoms, function, quality of life, and mood (Busch et al., 2011) as other, more traditional exercise regimens.

Guidelines for exercise in patients with chronic widespread pain

Despite the strong evidence supporting the use of exercise as a component of CMP therapy, the requisite information to create specific prescriptions for the optimal mode, frequency, duration, or intensity for treatment is currently lacking. In 2005, the American Pain Society published their aerobic exercise recommendation for patients with FM (Burckhardt et al., 2005), which advocated for moderately intense activity (60–75% of age-adjusted heart rate maximum), 2–3 times/week. This recommendation, however, was based on the false supposition that improved fitness was necessary to treat FM symptoms and has since been abandoned. Häuser et al. (2010)

published a meta-analytic review on aerobic exercise with a stated objective of identifying evidence-based recommendations for optimal intensity and volume. They concluded that land- or water-based exercise performed at a moderate intensity (>50% of age-adjusted heart rate maximum) 2–3 times/week, for at least 4 weeks should result in improved symptoms while minimizing the likelihood of exacerbation. It is our position that the evidence does not support such a specific recommendation. In point of fact, the authors relied on the effect sizes of interventions derived from their meta-analytical investigation to draw their conclusions and none of the studies included in their analysis directly compared interventions of varying intensity or volume.

Of course, precise recommendations in terms of mode, frequency, duration, and intensity for particular symptoms associated with CMP would be the ideal. Unfortunately, the accumulated knowledge on exercise as it affects CMP is insufficient to make those kinds of recommendations. However, numerous less specific, evidence-based guidelines have been put forward for consideration when using exercise or strategies to increase physical activity in patients with CMP. When initiating a new exercise regimen, CMP patients should start at a low intensity and progress slowly. Low-intensity exercise appears to be more conducive to adherence and less likely to provoke symptom exacerbation (Busch et al., 2008; Cazzola et al., 2010; Thomas & Blotman, 2010). While low-intensity exercise is less likely to positively impact fitness, it may be enough to improve symptoms (Busch et al., 2008). Interventions should be individualized, taking into account current fitness and symptoms of the patient (e.g., if muscular weakness and fatigue are particular problems then the program should include some strength training exercises (Busch et al., 2008; Cazzola et al., 2010; Thomas & Blotman, 2010)). Patient preferences for particular modes of exercise should shape the program, but various types of exercise should be incorporated (Cazzola et al., 2010). Patients should be counseled to expect some increases in pain when starting a new regimen. If symptoms are aggravated, patients should reduce their intensity while trying to maintain their frequency (Cazzola et al., 2010; Thomas & Blotman, 2010). Supervised exercise programs, especially for new exercisers, are recommended as a way to provide education and facilitate adherence (Busch et al., 2008; Thomas & Blotman, 2010).

Rheumatoid arthritis

Rheumatoid arthritis (RA) is diagnosed based on the ACR criteria (1987) and common symptoms include systemic inflammation of peripheral joints, pain, fatigue, stiffness, impaired range of motion, and difficulties in activities of daily living (Woolf & Pfleger, 2003; Bilberg, Ahlmen, & Mannerkorpi, 2005). Prevalence rates of RA have been reported to range from 0.45% to 1.16% of the female population and 0.19% to 0.44% of males, but rates appear to vary across geographic regions (Guillemin et al., 2005; Symmons et al., 2002). RA patients self-report significantly lower total energy expenditure and less moderate-intensity physical activity when compared to age- and gender-matched controls (Henchoz et al., 2012). Further, RA patients with higher amounts of sedentary behavior report significantly greater pain, fatigue, and disability compared to more physically active RA patients (Henchoz et al., 2012). Thus, exercise has been examined as an adjunct treatment in this population as a means to increase strength, aerobic capacity, and reduce the pain associated with RA.

Exercise in rheumatoid arthritis

Both aerobic exercise training and resistance training can be completed safely by patients with RA. Regular aerobic exercise results in significant reductions in pain and disability while

increasing functional ability, aerobic capacity, and quality of life (Metsios et al., 2008; Baillet et al., 2010). Improvements are greater for patients with longer illness duration and for those who exercise more frequently (Baillet et al., 2010). Resistance training leads to significant improvements in strength and functional capacity, and decreases in swollen joint counts, but evidence for reductions in RA pain associated with resistance training is less consistent (Baillet, Vaillant, Guinot, Juvin, & Gaudin, 2012). Short- and long-term exercise interventions are both efficacious for lessening RA symptoms, but the specific exercise mode, duration, and intensity necessary to elicit these results is unknown (Hurkmans, van der Giesen, Vliet Vlieland, Schoones, & Van den Ende, 2009).

Guidelines for exercise in rheumatoid arthritis

Although there are a growing number of randomized controlled exercise trials that report significant reductions in pain in RA patients, the dose of exercise needed is unknown, which may explain why exercise is not explicitly present in most guidelines developed for the treatment for RA. The National Institute for Health and Clinical Excellence (NICE) in the United Kingdom recommends a multidisciplinary treatment of RA, including consultation with a specialized physiotherapist and increasing fitness and regular exercise for enhancing joint flexibility and strengthening (National Collaborating Centre for Chronic Conditions, 2009). Further, the ACR emphasizes the use of medications in their RA practice guidelines but also maintains a helpful web page dedicated to the beneficial aspects of engaging in physical activity for arthritis patients (Westby, 2012). On the other hand, the most recent Cochrane Review suggested that employing treatment strategies that will improve aerobic capacity and muscle strength should be routine practice for RA patients (Hurkmans et al., 2009). The Ottawa Panel, an expert commission of Canadian methodologists and researchers, published evidence-based guidelines recommending the use of exercise for specific joint and overall functional strengthening to manage RA symptoms but a detailed prescription is not provided (Brosseau et al., 2011).

Osteoarthritis

Osteoarthritis (OA) is a common chronic joint pain condition that has been reported to affect 12.8% of the population including approximately 15% of women and 10.5% of men (Grotle, Hagen, Natvig, Dahl, & Kvien, 2008). The symptoms associated with OA include joint pain, limitation of joint range of motion, impaired joint stability, inflammation, and tenderness (Woolf & Pfleger, 2003). Common joints that are affected by OA are the knee, hip, and hand. In addition to pain symptoms, this condition can impact activities of daily living and quality of life (van Es et al., 2011). Exercise is recommended with the goal of increasing the ability to complete activities of daily living, increasing muscle strength, improving overall physical function, and decreasing pain.

Exercise in osteoarthritis

Aerobic activity (weight-bearing and non-weight-bearing), strength training (dynamic and isometric), and combined (both aerobic and anaerobic) exercise interventions have been shown to be beneficial for pain reduction in OA (Focht, 2006; Iwamoto, Sato, Takeda, & Matsumoto, 2011). Further, walking and strengthening exercises are equally effective in reducing knee OA pain (Roddy, Zhang, & Doherty, 2005). There is clear evidence of symptom improvement immediately following exercise interventions, but the long-term follow-up effects on OA pain are less clear (Pisters et al., 2007).

Guidelines for exercise in osteoarthritis

Exercise as a treatment for OA appears more frequently in guidelines compared to RA. For example, recently the ACR published five nonpharmacologic recommendations for the management of knee and hip OA, which include participation in cardiovascular and/or resistance exercise (Hochberg et al., 2012). NICE suggests a holistic approach, which specifically emphasizes the role of general exercise and local strengthening as a core component of OA treatment (National Collaborating Centre for Chronic Conditions, 2008). The European League Against Rheumatism (EULAR) released 10 recommendations for hip OA treatment that involve non-pharmacological interventions including regular education, exercise, and weight reduction if overweight (Zhang et al., 2005). In normal-weight OA patients, the Ottawa Panel recommends strengthening exercises, general physical activity, and manual therapy combined with exercise for the management of pain and improvement in functional status (Loew et al., 2012). The Ottawa Panel also recommends knee OA patients participate in aerobic walking combined with stretching and strengthening exercises to clinically improve pain, functional status, and quality of life (Loew et al., 2012). The Ottawa Panel concluded that for overweight patients with OA, a combination of physical activity and diet would result in clinically relevant improvement in pain relief, strength, and functional status (Brosseau et al., 2011). Although the specific parameters for the most effective exercise interventions have not been defined, exercise in some form appears to be consistently recommended in the treatment of OA.

Low back pain

Low back pain (LBP) is usually defined by its etiology (specific vs. unspecific), and duration (acute, subacute, and chronic). Low back pain refers to pain that is localized near the lumbar vertebrae and can be accompanied by sciatic nerve pain. Specific back pain, or pain from a known cause (e.g., disc displacement, tumors, etc.), is rare, usually ~10% of LBP cases, and treatments in these cases are focused on the underlying condition and not the back pain itself. Thus, the majority of LBP cases are of unknown etiology and treatments are focused on symptoms. Acute back pain is generally defined as being present for less than 6 weeks, while subacute back pain is defined as being present for between 6 weeks and 3 months. Chronic LBP includes all incidents lasting longer than 3 months. The incidence of LBP in adults in the United States was estimated to be about 26% over a 3-month period (Deyo, Mirza, & Martin, 2006). In England, data suggests that 28% of adults report LBP in a 1-month period (Macfarlane et al., 2012). This is consistent with Andersson's 1999 report suggesting as many as 85% of people suffer from back pain at some point in their lives. Importantly, this report shows that 60–70% of patients recover from their LBP within 6 weeks and 80–90% of patients recover within 12 weeks. For those whose pain does become chronic LBP, recovery is uncertain and returning to work is rare and may take years.

Exercise and low back pain

With the push for evidence-based medicine, there have been a large number of studies conducted to determine the efficacy of different treatments for LBP. These interventions generally target chronic LBP symptoms, include some type of exercise (e.g., yoga, strengthening, aerobic exercise, etc.) and focus on changes in pain ratings as the primary outcome. A number of reviews detailing the effects of exercise on LBP exist (e.g., Bell & Burnett, 2009; van Middelkoop et al., 2011) and conclude that exercise is a generally efficacious treatment. Other studies have looked at

exercise therapy compared to traditional treatments (e.g., Ferreira et al., 2007; Mannion, Muntener, Taimela, & Dvorak, 1999), finding that exercise is a favorable therapy compared to usual care and is the same as or better than motor control therapy or active physiotherapy. The negative side effects of exercise therapy for LBP appear to be nominal, as adverse events are rarely reported. Therefore, exercise has been shown to be a safe and effective treatment option for people suffering from chronic LBP. Macedo and colleagues (Macedo, Maher, Latimer, & McAuley, 2009) put together a critical review of studies using motor control therapy (an approach using motor learning principles to retrain the lower back muscles) in chronic LBP and found it to be a more effective treatment than usual care, but not any better than other exercise modes. The general consensus is that exercise decreases pain scores in patients with chronic LBP, although the most efficacious intensity, duration, and mode of exercise have not yet been identified. Regular exercise reduces the risk of LBP recurrences if continued following initial pain treatment (Choi, Verbeek, Tam, & Jiang, 2010).

Guidelines for exercise in lower back pain

A number of organizations have published guidelines for the effective management and treatment of LBP. Almost all guidelines include recommendations to increase physical activity through structured exercise, or at a minimum, focus on maintaining current levels of physical activity. The American College of Physicians and the American Pain Society jointly recommend both exercise and yoga as effective forms of treatment for acute and chronic LBP (Chou, Huffman, American Pain Society, & American College of Physicians, 2007). In 2001, the Philadelphia Panel for Evidence-Based Clinical Practice Guidelines (Philadelphia Panel, 2001a) recommended continued daily activities (no specific change in exercise, just maintenance) for acute LBP, with recommendations for both subacute and chronic back pain sufferers to use exercise as a frontline treatment for pain. However, the addition of aerobic exercise to conventional physiotherapy rather than in place of regular treatment is not always recommended and should be prescribed cautiously (Chan, Mok, & Yeung, 2011). Without evidence of specific exercise programs being superior, it seems practical to permit patients the option to select an activity they prefer and enjoy. Overall, most back pain treatment recommendations will include limited pharmacotherapy in conjunction with exercise therapy with specific recommendations depending on the individual case.

Headache

Headaches can vary in type and their pain symptoms are often described in terms of intensity and duration. Lifetime prevalence for tension-type headaches (TTH) is reported to be 46%, migraine 14%, and chronic daily headache 2.9% (Stovner et al., 2007). In the United States, the general prevalence of migraines is estimated to be 18.2% for women and 6.5% for men, with the highest overall prevalence occurring between the ages of 30 and 39 years (Lipton, Stewart, Diamond, Diamond, & Reed, 2001).

Exercise in headache patients

Tension-type headaches have been suggested to involve muscular pathophysiology (Millea & Brodie, 2002) and as such various physical therapies have been explored. Biondi (2005) concluded that physical therapy is more effective than massage or acupuncture for TTH in individuals with migraine, although physical therapy in conjunction with other treatments is most effective.

Limited evidence suggests that stretching and posture exercises have modest positive effects for TTH and accompanying muscle pain, while the evidence for repetitive motion, resistance training, and conditioning exercises is inconclusive (Fricton, 2007).

Migraine headaches have been reported to be associated with severe impairment and reduction of daily activity and involve a disruption in neural vascular activity (Davies, 2011; Lipton et al., 2001). In general, exercise research for migraine has been of poor quality and recommendations for exercise have been cautiously supported (Busch & Gaul, 2008; Biondi, 2005). One study examined the effectiveness of 1 hour of supervised aerobic exercise 3 times/week over an 8-week treatment period compared to a control group taking medication (Narin, Pinar, Erbas, Ozturk, & Idiman, 2003). Both groups reported decreases in the frequency of pain and pain disability, but the exercise group reported significantly more pain relief compared to the control group, supporting a potentially therapeutic effect of aerobic exercise on migraine pain (Narin et al., 2003).

Guidelines for exercise in headache patients

Although there are several headache organizations (e.g., American Academy of Neurology) that advocate the use of exercise for headache treatment, they lack specific guidelines. One evidence-based guideline for the treatment of migraines focuses on the use of medication and recommends that behavioral and physical interventions be used primarily for prevention rather than acute alleviation (Silberstein, 2000). The British Association for the Study of Headaches (2010) suggests that relaxation therapy, stress reduction, and coping should be frontline therapies for migraine. The European Federation of Neurological Societies suggests that although physical therapy may be a viable therapy for TTH, the lack of scientific evidence prevents specific recommendations (Bendtsen et al., 2010).

Chronic neck pain

Chronic neck pain has been reported to affect nearly 10% of the general population and has been identified as an ailment associated with the changes in workplace environments over the past century (Cote et al., 2008). The 12-month prevalence rate is between 30% and 50%, and is accompanied by limited ability to work and engage in social activities (Hogg-Johnson et al., 2008). Because weak musculature surrounding the neck has been suggested to be a potential cause of neck pain, strengthening exercises have been proposed as an active treatment.

Exercise in chronic neck pain

Exercise interventions focused on the neck musculature have resulted in moderate to large improvements in neck pain when compared to mock treatment, advice therapy, or no-treatment controls, and small to moderate improvements when compared to general practitioner care (Miller et al., 2010). Though this body of literature generally supports strengthening of shoulder and neck muscles to treat chronic neck pain, the protocols used for strengthening have varied, have not been well defined, or have been used in combination with other therapies. Thus, the most effective intervention for chronic neck pain has yet to be determined.

Guidelines for exercise in chronic neck pain patients

The Philadelphia Panel concluded that there is scientific evidence to support and recommend the use of proprioceptive and therapeutic exercises for chronic neck pain, but not thermotherapy,

therapeutic massage, EMG biofeedback, mechanical traction, therapeutic ultrasound, or electrical stimulation (Philadelphia Panel, 2001b). Further, the Oklahoma Physician Advisory Committee recommends that an exercise program used to treat neck pain should include strength, endurance, flexibility, and educational components (Physician Advisory Committee, 1997). Specifically, the guidelines suggest that a conservative exercise treatment should be adopted before progressing to regular aerobic exercise and supervised therapeutic exercises. The American Physical Therapy Association recommends cervical manipulation and mobilization along with coordinating, strengthening, and endurance exercises in the treatment of neck pain (Childs et al., 2008).

Conclusions

Summary and limitations of exercise research in chronic pain conditions

Overall, exercise appears to have consistent and positive benefits for a multitude of chronic pain conditions with few adverse outcomes. As is the case for healthy individuals, the most common side effects of exercise are positive and include improved cardiopulmonary and mental health. Although much is known about the effect of exercise on pain in a variety of conditions, conclusions need to be made in light of the limitations in study design and execution including (1) rare use of attention-control conditions, (2) frequent comparison of different exercise therapies in the absence of no-treatment control conditions, (3) poorly defined exercise protocols that limit replication, (4) failure to report extra-intervention treatments and compliance rates, and (5) failure to measure extra-intervention physical activity. Although blinding is difficult in exercise studies, it is almost never done, which detracts from internal validity. These weaknesses in study design minimize the impact of recommending exercise as a specific treatment, and need to be taken into account when planning future studies. Research that directly compares different modes, intensities, and durations of exercise are needed to provide evidence-based prescriptions about dose response and to determine whether reductions in pain are related to improved strength and/or aerobic capacity. In regard to exercise prescription, it would be a mistake to rely on previously generated guidelines designed for specific health and fitness outcomes using data collected from healthy individuals and assume they can be adapted to suit the needs of chronic pain patients. Health and fitness outcomes are important, but exercise prescription for chronic pain needs to be based on data from patients suffering from these conditions. There is a need for research aimed at determining for whom and why exercise is an efficacious treatment of chronic pain. Currently, there appears to be an absence of treatment trials designed to uncover the psychobiological mechanisms responsible for symptom improvement in chronic pain patients following exercise training.

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