The Evidence of Physical Activity and Training for the Therapy of Chronic Non-Specific Back Pain

Die Evidenz von körperlicher Aktivität und Training zur Therapie chronisch unspezifischer Rückenschmerzen

Summary

- **Problem:** Physical activity has an enormous relevance for the treatment of back pain (BP) in the clinical field. This paper gives a brief overview of the evidence of physical activity for the treatment of chronic back pain and summarizes the current approach of the German national project Medicine in Spine Exercise (MiSpEx: sensorimotor training (SMT) with perturbation).
- **Methods:** 35 literature reviews were screened for inclusion criteria concerning physical activity for the treatment of BP. Of these, 16 systematic reviews and 2 guidelines were included following the criteria: systematic review in English, evaluating pain and disability in the context of physical activity for the treatment of back pain, published 2000-2017 and considering less than a third of RCTs without a subclassification of patients. We did not conduct a quantitative meta-analysis but a qualitative synthesis.
- **Results:** Exercise Therapy reduces pain and disability in BP patients but there is still no evidence that any one specific approach is the most favorable. Motor control exercises (MCE) seem to improve outcomes best, but SMT was mostly unconsidered.
- **Conclusion:** SMT further improves motor control by training the adjustment to unexpected stimuli in complex tasks considering both: afferent and efferent workloads. Furthermore, additional perturbation may improve sensorimotor adaptations through higher demands on core stability and increase the precise stabilizing feedback in BP patients.

**KEY WORDS:** Exercise Therapy, Chronic Back Pain, Sensorimotor Training, Proprioception

Zusammenfassung

- **Problem:** Patienten mit subakuten und chronischen nicht-spezifischen Rückenschmerzen (RB) profitieren im Allgemeinen von einer Bewegungstherapie. Diese Publikation gibt einen Überblick über die Evidenz körperlicher Aktivität für die Therapie chronischer RB und begründet damit den Forschungsansatz des aktuellen Projekts des deutschen Forschungsnetzwerks MiSpEx (sensomotorische Intervention inkl. Perturbation) vor.
- **Methodik:** Es wurden 35 international veröffentlichte Reviews zur Wirksamkeit körperlicher Aktivität als Therapeutikum bei chronischen RB berücksichtigt sowie 16 systematische Reviews und 2 Richtlinien in die endgültige Analyse nach folgenden Kriterien aufgenommen: systematische Reviews in englischer Sprache mit den Outcomes Schmerz und Einschränkungen im Kontext physischer Aktivität für die Behandlung von Rückenschmerz, publiziert zwischen 2000-2017, die weniger als ein Drittel RCTs ohne Subklassifizierung der Patienten integrierten. Die Daten wurden rein qualitativ zusammenggeführt, d.h. es erfolgte keine quantitative Metaanalyse.
- **Ergebnisse:** Bewegungstherapie verringert nachweislich den Schmerz und die funktionellen Beeinträchtigungen bei Patienten mit chronischen RB. Aktuell existiert keine Evidenz, dass einer speziellen Trainingsmethodik Präferenz eingeräumt, es gibt aber Hinweise, dass ein Training der motorischen Kontrolle den größten Effekt auf den Therapieerfolg hat. Diesbezüglich finden sich allerdings bislang nur wenige Studien, die das spezielle sensomotorische Training berücksichtigen.
- **Fazit:** Sensomotorisches Training, welches die motorische Kontrolle und damit die Reaktion auf unerwartete Störreize trainiert, ist eine vielversprechende Form der Bewegungstherapie bei Patienten mit chronischen RB. Additive Perturbationen scheinen durch die erhöhte Beanspruchung der posturalen Kontrolle, zusätzliche positive Effekte auf die Feedbackkontrolle der stabilisierenden Strukturen aufzuweisen.

**SCHLÜSSELWÖRTER:** Bewegungstherapie, chronische Rückenschmerzen, sensomotorisches Training, Propriozeption

Introduction, Problems and Objectives

Muscle strength, endurance and neuromuscular coordination have been shown to be related to cBP as their dysfunctions decreases spinal stability (7, 22, 34, 61, 65). Several authors have reported a lower level of activity and muscle atrophy for cBP patients (cBPP) (6, 20, 71, 76), whereby especially the motor control of the lumbar region is decreased (70). Additionally, a less refined proprioception in cBPP as a sensorimotor dysfunction has been found disturbing the precise stabilizing feedback control (37, 60, 62) and therefore probably leading to changes in postural control (14, 26, 37, 56). This maladaptation may eventually lead to relevant programming changes in the central nervous system (CNS) in cBPP (35, 37, 59).
Exercise therapy is the first-line treatment according to the European Guidelines for the Management of chronic non-specific BP (cnBP) (1). Its overall aim is to reduce BP via specific exercises to lead cBP towards a higher loading capacity, a recovery of resilience for (occupational) activities of daily living and a reduction of fear avoidance behavior (8, 58). Thereby, physical activity (PA) not only leads to morphologic, e.g. muscle hypertrophy, flexibility (range of motion) and posture as well as neuronal (inter- and intramuscular) adaptations (10) but is also able to enhance psychosocial well-being as it may reduce stress, anxiety, and depression and improve self-esteem as well as the quality of life (16).

Strengthening exercise and segmental stabilization have been found to reduce pain and functional disability (24). Through a recalibration or normalization of physical activity (PA), a reduction of pain experience and its threshold may be reached even better than medically (4, 38). Basic muscle strength reflects the foundation of every other training phase and can be reached either by hypertrophy or neuronal adaptation. In conclusion, proper training stimuli lead to the optimal physiological performance achieved through neuronal adaptation, followed by hypertrophy (10, 12).

The focus of exercise therapy in back pain patients in recent years has been lying on core stability with specific training characteristics of studies included in the systematic review.

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<th>AUTHOR</th>
<th>YEAR</th>
<th>TYPE</th>
<th>RESULTS</th>
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<tr>
<td>Hartigan et al. [47]</td>
<td>2018</td>
<td>Review</td>
<td>Exercise prevents recurrence of BP</td>
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<td>Exercise Therapy with pain and disability reduction in back pain (cBP)</td>
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<td>Kinser et al. [48]</td>
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<td>Gentle physical activity and yoga-based interventions recommended for LBP patients (LBPP) and related symptoms</td>
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<td>Review</td>
<td>Combination of different approaches are most promising for BP Therapy</td>
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<td>Saragiotto et al. [21]</td>
<td>2016</td>
<td>Review</td>
<td>MCE superior in pain and disability short- to midterm vs passive therapy</td>
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<td></td>
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<td>No significant differences between MCE and other Exercise Therapy</td>
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<td>Searle et al. [50]</td>
<td>2015</td>
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<td>Strength/Resistance training with small significant effect on pain</td>
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<td>Beneficial effect for strength/resistance and coordination/stabilization treatments over other Exercise Therapies</td>
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<td>van Middelkoop et al. [51]</td>
<td>2010</td>
<td>Review</td>
<td>Exercise effective for pain and disability</td>
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<td>No Exercise more effective than another</td>
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<td>Small effects overall</td>
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<td>Yue et al. [52]</td>
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<td>Sling Exercise not superior to any other Exercise Therapy</td>
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<td>Macedo et al. [53]</td>
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<td>Exercise therapy improved pain intensity and disability and long-term function compared to usual care</td>
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<td>van Middelkoop et al. [54]</td>
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<td>Review</td>
<td>Some Exercise interventions effective, others not</td>
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<td>Exercise approaches benefits beyond their intended physiologic goals</td>
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<td>Macedo et al. [25]</td>
<td>2009</td>
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<td>MCE superior to minimal intervention</td>
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<td>Not more effective than other Exercise Therapy</td>
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<td>Reduces Pain and Disability</td>
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<td>Keller et al. [56]</td>
<td>2007</td>
<td>Review</td>
<td>Exercise therapy with modest effect sizes for chronic LBP patients (cLBPP) compared to non-treatment controls</td>
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<td>Chou et al. [57]</td>
<td>2007</td>
<td>Guideline USA</td>
<td>First-line for chronic LBP (cLBPP): Exercise therapy and others like rehabilitation, acupuncture, massage, spinal manipulation and cognitive-behavioral therapy recommended</td>
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<tr>
<td>Airaksinen et al. [19]</td>
<td>2006</td>
<td>Guideline EUR</td>
<td>Supervised exercise therapy – beside other treatments – recommended for cLBPP</td>
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<td>First-line treatment BP: For cLBPP Exercise therapy superior over surgeries, medication or passive treatments</td>
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<td>Hayden et al. [58]</td>
<td>2005</td>
<td>Review</td>
<td>Individual Exercise therapy (strengthening and stretching) with supervision improves pain and function in cLBPP patients</td>
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<td>Adherence strategies important</td>
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<td>Rainville et al. [59]</td>
<td>2004</td>
<td>Review</td>
<td>Improvements in pain ratings and disability due to Exercise Therapy</td>
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<td>Exercise Therapy effective vs. impairments in back flexibility and strength</td>
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<td>Liddle et al. [60]</td>
<td>2004</td>
<td>Review</td>
<td>Exercise (strengthening and stretching) with positive and in follow-up maintaining effects in cLBPP patients</td>
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<td>Co-interventions important</td>
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<td>van Tulder et al. [61]</td>
<td>2000</td>
<td>Review</td>
<td>Exercise therapy more effective in cLBPP patients than usual care</td>
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<td>Conflicting evidence that strengthening exercises more effective than inactive treatment for cLBPP</td>
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<td>Specific back exercises with no clinical effect</td>
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Exercises for deep trunk muscles (e.g., Transversus Abdominis and Quadratus Lumborum) to provide a fine motor and postural control, muscle coordination and static as well as dynamic stability (7, 58, 66, 67).

However, certain literature reviews suggest that no exercise is favorable to another (5, 15, 17, 30, 50, 53, 77). Moreover, exercise interventions are not evaluated thoroughly regarding either the neuronal system with neurophysiologic reorganization as important component of cBP treatment (3, 11, 25, 36, 67, 80) or the dose-response relationship.

SMT (47, 67) seems to be promising as it not only improves core stability, postural control and pain alleviation but optimizes proprioception and neuromuscular coordination leading to an adaptation of cortical reorganization (3, 11, 25, 67). SMT (neuromuscular or proprioceptive training) is highly recommended for cBP (54, 59) as it "emphasizes postural control and progressive challenges to the sensorimotor system to restore normal motor programs" (59).

It aims at stimulating the proprioceptors for improving muscle response and endurance in dynamic environments, and therefore trains how well a system adapts to changing requirements (feedback control). External perturbation training triggers automatic postural responses to maintain stability even in complex situations (60) with rising uncertainties and disturbances (66) improving the afferent and efferent processes in time and efficiency (14, 19, 33, 46, 55, 59, 63, 72). Ultimately, SMT thereby modifies the afferent input on the CNS (10) in cBP especially of the injured or painful back muscle region as on unstable surfaces less reliable ankle joint proprioception is downweight and proximal proprioception is upweight. A change in these patterns (cortical reorganization) may decrease pain (recurrence), disability and increase fine postural control variability (3, 14). Additionally, through the perturbations in SMT, the participant focuses consciously on a non-painful stimulus which may help to revalue chronic pain (21, 69).

In total, through the destabilizing surfaces, additional perturbations and variable nature of SMT, it is highly efficient on (neuromuscular) functional performance, and pain reduction (36). Therefore, the aim of this short overview is to summarize recent reviews about the evidence of physical activity for the treatment of cBP regarding training method and dose-response.

**Methods**

This review is based on a literature research including international reviews covering the key words 'systematic review', 'physical activity', 'exercise therapy' and 'chronic back pain'. Thus, we performed an electronic search for relevant articles in the following databases (English language): Cochrane Database, Pubmed, MedLine and SPOFOR (01/2000-10/2017). Two authors independently searched for potentially relevant titles and abstracts based on the specified criteria. Disagreements were solved by a third independent reviewer.

From 326 identified publications regarding our search criteria, 243 were eliminated concerning their topic (non-invasive/physiotherapeutic treatments, drug use, different disease, acute trauma, economic view or psychological approach) and additional 48 duplicates were removed, leading to 35 full-text articles assessed for eligibility (Fig.1). The literature reviews were screened and we ended up with 16 systematic reviews matching our inclusion criteria (Tab. 1):

- Systematic reviews (Cochrane guidelines)
- Evaluating risk of bias
- Definition of the investigated intervention
- Topic of physical activity as a treatment of chronic non-specific back pain
- Published: 2000-2017
- Evaluating the outcomes: pain and disability
- Including less than 33% of RCT without a subclassification of patients

We additionally included 2 Guidelines for the treatment of back pain (European & American) to consider the current state of the art.

Due to the limited data, missing homogenous subclassification of patients and diverse definitions of back pain we did not conduct a quantitative meta-analysis but only a qualitative synthesis.

**Results**

In reviewing the literature, low to moderate evidence was found on the effect of physical activity as a treatment for cLBP in terms of pain and disability reduction. Several authors recapitulate that neither general nor specific approaches are preferable but the combination of different methods of training (27, 31, 32, 49, 75).

All exercise therapies MCE (67), Pilates (44, 45), Yoga (79), Stretching (40), Whole-body vibration training (39), proprioceptive neuromuscular facilitation (PNF) (2, 42), aerobic exercise and resistance training (1) have been shown to reduce pain and disability as well as to prevent BP reoccurrence being superior over no exercises in cBP. Nevertheless, there is still no evidence of one treatment superior to another in cBP patients (cBPP).
A major problem in studies dealing with the topic of exercise therapy seems to be the integration of subclassification strategies. Out of 68 investigations, less than 8% subclassified patients beyond inclusion and exclusion criteria, leading to low quality research (23). Additionally, most RCTs not only lack in clear description and standardization of the intervention applied, but are planned as short- to midterm investigations. Thus, no review was able to give evidence based advices regarding to training specific parameters, especially in the long-term.

**Conclusion**

This paper set out with the aim of assessing the importance of physical activity for the treatment of chronic back pain. Based upon an overview of current reviews dedicated to the effects of different exercise approaches, it further supports the idea of physical training as first line therapy. Although, no exercise seems favorable to another, it appears that MCE seem to be most promising in the field of short- to midterm reduction in pain and disability. Precise voluntary/efferent stimuli thus may enhance control and coordination of deep and global trunk muscles to reduce pain and disability.

Surprisingly, the concept of sensorimotor exercises has not previously been described in a systematic literature review, even though it proves to enhance neuromuscular performance, especially in dynamic environments. Considering afferent and efferent workloads, SMT further improves motor control by training the adjustment to unexpected stimuli at complex tasks. These ideas match those observed in the MiSpEx studies and suggest that SMT is able to produce superior outcomes compared to simple MCE. Additionally, current research evaluates possible secondary effects of additional perturbations during SMT for BPP. It is hypothesized that sensorimotor adaptations to motor control by training the adjustment to unexpected afferent and efferent workloads, SMT further improves motor control can be improved decisively through higher demands on core stability.

**Training Advice**

Several reports have shown that no exercise therapy is favorable to another for the treatment of cBPP, although it must be mentioned that very little was found in the literature on the question of SMT effectiveness and effect size. Additionally, existing studies and reviews have inconsistently noted methods of SMT to achieve neuromuscular adaptations.

Generally, the World Health Organization (WHO) advises “muscle-strengthening activities [...] on 2 or more days a week” (78) for adults aged 18 to 65, reflecting rather a minimal (muscle maintenance) than an optimal (muscle enhancement) recommendation (29). A positive impact of SMT in such frequency has already been shown for a German cBPP population by the MiSpEx research network (52). Therefore, taking several studies into account, it appears that 2 to 3 times SMT per week over a period of 12 weeks seems to be a promising frequency of exercise for the treatment of cBPP.

Saragiotto et al. (67) advice that future investigations and interventions need to include a precise description of the exercises, an adequate sample size, significant long-term results, a different perspective on responders/non-responders and an economic perspective as well (67). Considering the MiSpEx setup since 2013, including over 34 studies with an overall sample size of >2000, moderating factors within the psychosocial context, a follow-up period of 1 year and developing a transfer concept for the health care system, it covers all aspects to add to the current state of research.

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Evidence of Training for the Therapy of Chronic Back Pain

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