Journal of Bodywork & Movement Therapies 24 (2020) 289–299

Contents lists available at ScienceDirect

Journal of Bodywork & Movement Therapies

journal homepage: www.elsevier.com/jbmt

# Back rehabilitation – The 3R's approach

Christopher M. Norris

*Norris Health, 16, Lawton Street, Congleton, Cheshire, CW12 1RP, UK*

ARTICLE INFO

*Article history:*
Received 23 October 2019
Accepted 23 October 2019

ABSTRACT

Exercise is vital to the management of low back pain (LBP). However, research, social media, and fitness industry interests can leave therapists confused about best practice in exercise prescription for this clinical condition. The 3R's approach to back rehabilitation is introduced as an evidence-based framework for developing patient specific exercise throughout the back-pain journey. Clinical guidelines for the management of LBP are presented, and both exercise and psychological considerations are overviewed. The contrast between biomedical and biopsychosocial models of healthcare is introduced in relation to LBP and the requirements of a successful rehabilitation programme. Interacting factors in LBP, red flags, and motor skill classification are considered. The concept of tissue capacity is introduced, and the healing timescale addressed. Both are used as a foundation for exercise choice and progression. Simple methods of structuring an exercise programme are drawn from the fitness industry and adapted for use in rehabilitation. The 3R's approach consists of 3 interrelated and overlapping phases – reactive, recovery, and resilience. Treatment aims for each are introduced with guidance given to indicate appropriate patient progression between phases. Exercise examples of each stage are illustrated with consideration given to clinical reasoning, teaching method, safety and effectiveness.



## 1. Introduction

Low back pain (LBP) is a common clinical condition, which may present as an acute (<6 weeks), sub-acute (6–12 weeks) or chronic (>12 weeks) incident (CLBP). Prevalence of CLBP in individuals between 20 and 59 years is 19.6% rising to 25.4% in those older (Meucci et al 2015). Both pain and disability are described, with CLBP reported as the leading cause of years lived with disability (Hurwitz et al 2018). Relapse of the condition is common, with as many as two thirds of individuals having a recurrence within 12 months of initial onset (da Silva et al 2019). Non-specific LBP is low back pain not attributable to a known cause and represents up to 95% of cases (Bardin et al 2017). Despite extensive research in this area, disability levels have failed to improve (Tousignant-Laflamme et al 2017).

### 1.1. Guidelines

Clinical practice guidelines for the management of non-specific LBP in primary care (Oliveira et al 2018) recommend history taking and physical examination to identify red flags which may indicate a possible serious pathology requiring onward referral. Neurological testing is used where radicular syndrome is suspected, with imaging used only if a more serious pathology is suspected. This type of assessment can categorise low back pain into non-specific LBP, radiculopathy or specific LBP. Neurological examination may include straight leg raise (SLR), and assessment of strength, sensation and reflexes. Imaging is discouraged for routine usage.

General recommendations for the management of non-specific LBP are non-pharmacological and non-invasive with advice to stay active and to use patient education and exercise therapy (O'Connell et al 2016). Reassurance of a favourable prognosis, advice on returning to normal activities, and the avoidance of bed rest are all suggested. The use of nonsteroidal anti-inflammatory drugs (NSAIDs) and weak opioids is indicated for short periods only. Exercise therapy and advice are important with secondary referral where there are red flags, radiculopathy or no improvement after 4 weeks.

In the NICE (National Institute for Health and Care Excellence) guidelines on the treatment of LBP, exercise is a key treatment modality, with manual therapy and psychological therapies only to be considered as part of a treatment programme which includes exercise (NICE, 2016). The focus is on self-management of LBP (with or without sciatica) at all steps of the treatment pathway. The guidelines emphasise that no one exercise type is superior to

*E-mail address:* info@norrishealth.co.uk.

https://doi.org/10.1016/j.jbmt.2019.10.016

another, the choice of exercise intervention should consider patient needs, preferences and capabilities. Psychological interventions are recommended where psychosocial factors (yellow flags) are identified at assessment and limit recovery.

### *1.2. Exercise and psychological interventions*

Exercise types used in the management of CLBP include (but are not limited to) aerobic exercise, strength/resistance exercise, coordination/stabilization exercise, motor control, and Pilates or Yoga. All have been shown to effectively reduce pain and disability (compared to passive or no intervention), but no differences have been found between the different exercise modalities (Malfliet et al 2019). Where time is a limiting factor to compliance with home exercise programmes, walking interventions may be used as they have been shown to improve pain, quality of life, disability and fear avoidance to a similar degree as exercise in patients with CLBP (Vanti et al 2019).

Reductions of pain and/or disability resulting from exercise therapy have been shown to be unrelated to musculoskeletal improvements such as mobility, trunk extension strength, trunk flexion strength, and back muscle endurance (Steiger et al 2012). This may suggest that changes in psychological factors may be more important drivers of improvement in pain or disability related to CLBP.

Focusing on a single method of treatment or a single exercise therapy approach (monodisciplinary treatment) is generally less effective than combining exercise therapy with behavioural/psychological approaches (multidisciplinary treatment). Long term follow up (1 year) showing better improvement, measured as sick-leave days (Roche-Leboucher et al 2011), and reducing disability, fear-avoidance beliefs and pain, and enhancing patient quality of life (Monticone et al 2013).

Psychological interventions when used in isolation can be effective in the management of CLBP but have shown equal results to active exercise interventions (Hoffman et al 2007). The use of pain neuroscience education (PNE) and cognition targeted exercise has been shown to reduce central sensitization and improve disability (maintained for 12 months) when used as a monodisciplinary approach (Malfliet et al 2018). PNE aims to reconceptualise pain relating it to an alteration of central nervous system processing ('software' metaphor) rather than a direct result of tissue damage ('hardware' metaphor) explaining the usual lack of significant findings on imaging. In this way, PNE aims to reduce the threat value of pain to reduce kinesiophobia and disability in the short term especially (Malfliet et al 2019). Both PNE and exercise therapy show strong evidence of benefit on pain and function in musculoskeletal conditions, compared to only moderate benefit (modest effect sizes) for non-steroidal anti-inflammatory drugs (NSAIDs) and opioids (Babatunde et al 2017).

Exercise therapy may be given in a form which creates a bridge between psychological and physical interventions to emphasise a biopsychosocial approach to patient management. Cognition targeted exercise focuses on stopping an exercise/activity at a specific time (time-contingent) rather than as the result of discomfort or pain (symptom-contingent). Such as approach relies heavily on establishing a therapeutic alliance between the patient and therapist, the latter acting as instructor rather than taskmaster.

Graded activity and graded exposure may also provide a biopsychosocial link. Graded exposure introduces activities which a patient fears (e.g. flexion or lifting) in a hierarchical fashion (least feared progressing to most feared) to gradually increase confidence and capability. Graded activity is more physical in its aims, as it progresses components of an exercise (e.g. strength, range of motion, aerobic fitness) applying overload with the aim of achieving tissue adaptation. Graded exposure has been shown to be more effective than graded activity in decreasing catastrophizing in the short term (Lopez-de-Uralde-Villanueva et al 2016).

## 2. Back pain, tissue capacity and healing

### *2.1. Tissue capacity*

Back pain is a condition which affects the whole person rather than an isolated tissue. However, the concept of tissue overload typically used in the management of peripheral soft tissue injury, can provide a useful guideline to structuring a back-rehabilitation programme. Tissue overload occurs when the load imposed on a tissue exceeds its capacity; the capacity in this case being how much the tissue can be loaded or stressed without breaking down. Tissue capacity will differ between individuals depending on the requirements of their work or sport, the condition of their tissues, and age. In any movement, several tissues may be loaded simultaneously, and the one with the lowest capacity represents the weakest link in the chain of movement and is often the one which breaks down (Cook and Docking, 2015). To maintain tissue capacity there is a continuous process of physiological maintenance via adaptations in the body's metabolism, a process which represents tissue homeostasis. Injury or overuse can disrupt homeostasis leading to a cascade of biochemical changes. Excessive (supra-physiological) loading on tissue will cause adaptation providing there is sufficient time for recovery. A sudden imposition of extreme force, however, may exceed the load capacity of tissue, leading to maladaptation (trauma). Similarly, repetitive small forces which occur too frequently may not allow enough time for the tissue to adapt to the new loading level (overuse). At the other extreme, too little (sub-physiological) loading, such as would occur with prolonged rest, also disrupts homeostasis leading to changes such as muscle atrophy and bone mineral loss, reflecting deconditioning and reduced tissue capacity (Norris, 2017).

The region of loading between under and over usage has been described as an 'envelope of function' and represents the area of load acceptance (Dye, 2005). Where loading exceeds the capacity of a bodypart, the action can be envisaged as occurring outside the envelope of function, and the tissues may enter the reactive phase of a musculoskeletal (MSK) condition. At this stage reducing or changing loading may restore homeostasis, with a view to later increasing tissue capacity with progressive exercise and elevating the upper limit of the functional envelope.

Poor load management can have effects both on the body as a whole, and at a local tissue level. Repetitive loading without sufficient recovery can cause cumulative tissue fatigue and increase susceptibility to injury. At whole body level inappropriate loading can prejudice a patient both psychologically and physiologically. Joint kinematics and neural feedback can be compromised with ongoing detriment to joint stability. Locally, excessive micro-damage may occur if the magnitude of loading is beyond the individual tissue's load bearing capacity. Initially when loaded, tissue changes are short term and reflect reaction. These include changes such as increased blood flow through muscle and increased metabolic activity. When loading stops, these changes are reversed, homeostasis restored, and the tissue resumes its resting state. Repeated loading causes the tissue to change more permanently, and adaptation occurs the tissue progressing to a recovery stage. Adaptation (for example increased muscle strength) allows the body to tolerate higher loads. Training loads which are too low may not stimulate adequate adaptation and can impair the tissues ability to cope with higher loads in the future. Effective training stimulates biological adaptation to increase the patient's capacity to accept and withstand load, building resilience.

### 2.2. Healing timescale

After injury, tissue heals following a defined timescale of interacting phases (Norris, 2019). Injury (tissue disruption) usually instigates inflammation, the two phases representing the reactive period of recovery when a patients tissues are irritable, and symptoms easily exacerbated. This phase typically lasts no longer than 3–4 days post injury, although tissue may be repeatedly re-irritated and re-enter the reactive phase. The reactive phase, traditionally called the acute phase of recovery, is followed by a sub-acute phase (which may last up to 14–21 days post injury) where inflammation leads to tissue regeneration. As irritability dies down and tissue can be loaded without increasing symptoms, the patient enters the recovery period. At the completion of this sub-acute phase (typically 3–6 weeks) tissue healing is complete, but the patient remains deconditioned (often termed the chronic phase of an injury). Rehabilitation now aims to build resilience to increase the body's capacity to withstand loading, enhancing performance and reducing the likelihood of re-injury. The terms reactive, recovery, and resilience are used as nomenclature within the 3R's approach.

One aim of 3R's rehabilitation is to increase the capacity of the injured tissue, and to offload it by enhancing the strength of surrounding muscle. Tissue capacity may be built with progressive overload, involving exercise which is either simple or complex. Simple loading targets the specific tissue (for example the medial collateral ligament of the knee), while complex loading targets the tissue within the context of the whole limb or body region (for example a squat action). The load chosen for 3R's back rehabilitation must accurately reflect the type of load the tissue may be placed under during any functional action in daily living or sport. Training specificity of this kind is vital to increase tissue capacity relevant to the patient's actions (patient centred) rather than increasing capacity to fulfil pre-determined goals (therapist centred).

## 3. Healthcare models

Healthcare models have evolved over the last century, from the traditional biomedical model towards a more holistic biopsychosocial approach (Engel, 1977), and this has particular significance in the management of LBP. The biopsychosocial (BPS) model stresses the importance of a complex interaction between biological (e.g. genetic, structure, chemical), psychological (e.g. mood, behaviour), and social (e.g. family, environment, culture) factors when treating a patient. This approach is less reductionist than the standard biomedical model which directly links structure to pathology (e.g. lumbar disc causing pain) seeing the body alone as responsible for symptoms. The biomedical model traces back to the 16th century and the work of Rene Descartes, with the view that the body and mind are separate (Cartesian dualism). The biomedical model remains dominant in the public understanding of illness, and frequently encourages isolated pathological diagnosis in healthcare. However, the BPS model underlies patient centred care, and may better demonstrate the true effect of disability (Wade and Halligan, 2017). The BPS model consists of three overlapping components which may be considered a mixture of science and the humanities, that is, normative data merging with narrative description (Low, 2018).

In relation to LBP, essential features comparing the biomedical and BPS models are highlighted in Table 1. From a biomedical perspective, the view is of a single tissue causing pain in a predetermined way. In this view greater pain means greater harm, pain intensity describing the degree of tissue damage. Further, the site of pain defines the site of damage, and so treating this area alone will give rise to a healing response. The BPS model in contrast, rationalises pain as an output of the brain designed to protect the body from further harm, either real or perceived. The nervous system senses the environment (both external and internal) and the brain interprets the signals received by comparing the information with past experiences, social norms, and beliefs for example. All regions of the brain play a role in the pain experience and are collectively described as a pain neurosignature, being part of the neuromatrix theory proposed by Melzack (1990).

Several BPS factors may interact in patients with LBP (Table 2). Physical influences include items such as alteration to movement patterns, maladaptive postures and general deconditioning. Cognitive factors include beliefs which the subject has about their condition, which have led to catastrophizing, hypervigilance, and poor self-efficacy. Thoughts that pain relates to tissue condition (hurt equals harm), the back is naturally fragile, something has ‘slipped out’, that discs are ‘worn’ will all limit recovery and must be addressed. Psychological influences include emotional response such as fear, anxiety and depression, and these may drive associated lifestyle changes such as sleep disorders and chronic stress responses. The social domain reflects influences from work, and home/family especially, and this may be either positive (support) or negative (judgemental). Finally, comorbidities may be important with some (such as obesity) influencing back pain and being modifiable, and others (such as chronic fatigue, irritable bowel syndrome) being related to back pain but less directly modifiable.

## 4. The 3R's approach

To improve clarity in the process of rehabilitation following back pain, the 3R's approach is suggested. The approach divides rehabilitation into three interrelated phases aligned with the healing timescale but representing the patient experience of injury and recovery.

### 4.1. Reactive phase

The reactive phase of the 3R's approach represents the stage in which the patient and therapist form an alliance. The patient is often fearful and in pain, so assessment, clinical reasoning and education form a major part of patient management at this stage. The reactive phase is the time when a treatment hypothesis is formed, and treatment plan outlined. Typical treatment aims in the reactive phase are highlighted in Table 3, but this can only be a general guide as they are dependent on assessment findings.

Assessment of the patient with a low back injury may begin using a diagnostic triage process by the first contact practitioner. Absence of red flags (Table 4) helps to rule out serious spinal pathology and identify those patients with non-specific LBP. A risk stratification such as the STarT back risk assessment tool (Hill et al 2011; Sowden et al 2018) can be useful to identify those at high risk of a poor treatment outcome. Additionally, patient prognosis, responsiveness to treatment, and possible underlying mechanisms may form part of a stratified care process to match patients to treatment subgroups (Foster et al 2015). Identifying those patients at low risk of a poor outcome ensures that patients are not overtreated or overmedicalized, and imaging is not routinely used (NICE 2016). Equally, identifying those at high risk ensures that yellow or red flags are not missed, and more intensive support is given where required, such as psychological intervention or onward referral.

Once treatment begins, patient education and maintenance of normal activity should form the primary part of care for those at low risk of a poor outcome, with self-management emphasised. The reactive phase of 3R's back rehabilitation represents the period where the patient's tissues may be irritable, and/or the patient

**Table 1**
Biomedical and Biopsychosocial models in Low Back Pain.

| Biomedical model | Biopsychosocial (BPS) model |
|---|---|
| • Tissue causes pain in a predetermined way<br>• Pain messages travel from tissue in specialised pain neuron to input into defined brain regions<br>• Pain intensity describes amount of tissue damage<br>• Site of pain defines site/type of tissue damaged<br>• Target tissue with modality and pain will reduce | • Interaction between biological, psychological and social factors<br>• Pain as a brain output to protect body from further harm<br>• PNS senses environment, interpretation of signals as threat by CNS<br>• Information assessed by brain compared to past experiences<br>• All regions of brain play role in pain experience – pain neuromatrix (cerebral signature) |

(PNS – peripheral nervous system, CNS – central nervous system).

**Table 2**
Interacting factors in Low Back Pain.

| Physical | Cognitive | Psychological | Lifestyle | Social | Co-morbidities |
|---|---|---|---|---|---|
| Maladaptive posture & movement patterns | Beliefs | Fear | Inactivity | Socioeconomic status | Obesity |
| Pain behaviour | Catastrophizing | Anxiety | Sleep disturbance | Family | Chronic fatigue |
| Deconditioning | Hypervigilance, | Depression | Life stress | Work | Irritable bowel syndrome |
| | Self efficacy | | | Culture | Inflammatory disorders |
| | Coping strategies | | | | Peripheral sensitization |

(Data from O'Keefe et al 2015; O'Sullivan, 2017).

**Table 3**
Reactive phase – treatment aims.

- Triage for red and yellow flags to determine direction of care
- Consider therapy to target pain (e.g. manual therapies/medication) and protect region to limit irritability (e.g. rest, activity modification, taping)
- Assess for increased levels of co-contraction (splinting) & hypervigilance.
- Encourage relaxed movement for short term benefit
- Pain education to challenge maladaptive beliefs
- Mindfulness/mindful movement/breathing/relaxation
- Aerobic exercise integrated into current lifestyle (exercise versus ‘function-cise’)
- Use appropriate exercise depending on contra-indications (isolation/protected progressing to compound)
- Decrease neural sensitivity & improve cortical body mapping.

**Table 4**
Red flags in the examination of Low Back Pain.

- Cauda equina syndrome.
  - Bilateral sciatica
  - Severe or progressive bilateral neurological deficit of the legs, such as major motor weakness with knee extension, ankle eversion, or foot dorsiflexion.
  - Difficulty initiating micturition or impaired sensation of urinary flow o Urinary retention with overflow urinary incontinence
  - Loss of sensation of rectal fullness or faecal incontinence
  - Saddle anaesthesia or paraesthesia).
  - Laxity of the anal sphincter.
- Spinal fracture.
  - Sudden onset of severe central spinal pain which is relieved by lying down.
  - History of major trauma (such as a road traffic collision or fall from a height), minor trauma, or even just strenuous lifting in people with osteoporosis or those taking corticosteroids.
  - Structural deformity of the spine (step) with possible point tenderness
- Cancer.
  - Patient aged >50 years of age
  - Gradual onset of symptoms.
  - Severe unremitting pain that remains when patient is supine
  - Aching night pain which disturbs sleep
  - Pain aggravated by straining at stool, or coughing/sneezing)
  - Localised spinal tenderness.
  - No symptomatic improvement after 4–6 weeks of conservative management
  - Unexplained weight loss.
  - Past history of cancer
- Infection
  - Fever
  - Tuberculosis, or recent urinary tract infection.
  - Diabetes.
  - History of intravenous drug use.
  - Patient immunocompromised

(Data from: Nice clinical knowledge summary - Sciatica (lumbar radiculopathy) https://cks.nice.org.uk/sciatica-lumbar-radiculopathy#!diagnosisSub:1 accessed September 19, 2019).

fearful. Local inflammation with or without tissue damage may occur. Unloading the reactive or damaged tissue by avoiding tissue stressing actions or protecting the area by using a support may allow the irritable tissues to settle, and anxiety to reduce. Low back pain is a multifactorial condition, which may occur without tissue damage. Where tissue damage is present, temporary reduction of activities may be required to allow symptoms to settle, with general (non-spinal specific) activity re-starting as soon as possible to avoid kinesiophobia.

Short term pain relief (hours, days) is often not considered significant in LBP trials which measure efficacy over long term outcomes (months, years). However, this type of relief is considered important by individuals suffering from the condition itself (Setchell et al 2019). Within the reactive phase of 3R's back rehabilitation short term pain relief is appropriate providing it is given alongside patient education which aims to firstly differentiate pain from tissue damage (hurt from harm), and secondly to reassure the patient that some pain is normal. The use of manual therapy (joint or soft tissue based), needling (acupuncture and dry needling), and supports (taping and braces), may all have their place with certain patients to enable them to get over a barrier to progress within 3R's back rehabilitation. No technique is superior to another, and none should be used long term or where patients become dependent upon them. Where possible, self-management should be encouraged with patients applying cold or hot packs, supports, or using resting positions to make them more comfortable as healing progresses. These aids should be used for pre-arranged time periods only, and in conjunction with clear aims and outcomes. Active strategies can be taught to find different ways to move in the reactive phase to ease pain an improve sleep patterns, and relaxation techniques may be used to reduce fear and anxiety, and muscle bracing.

### 4.2. Recovery phase

Treatment aims in the recovery phase of the 3R's approach are shown in Table 5. In any soft tissue injury, as regeneration begins, mechanical loading of the injured tissue may upregulate gene expression of proteins involved in regeneration, and mechanotransduction resulting from movement may enhance the healing process (Khan and Scott, 2009). The key question is often how much loading, and when. Optimal tissue loading has been defined as “the load applied to structures that maximises physiological adaptation” (Glasgow et al 2015).

In the case of peripheral soft tissue injuries, optimal loading must address both the mechanical properties of the affected tissues and the central nervous system (CNS), to challenge the complete neuromusculoskeletal system (Norris, 2017). Rather than simply increasing load on tissues we are seeking to increase variation in movement to encourage tissue adaptation in parallel with changes to motor control, and Glasgow et al. (2015) cite three categories in which load may be varied, an approach which may be adapted to back rehabilitation. Firstly, to reduce repetitive loading, magnitude, direction and rate of loading should be varied. Secondly stimulation of the mechanotransduction effect may be enhanced by varying loading to prevent accommodation to stimuli, where the body simply gets used to a stimulus and it no longer has a substantial effect. Finally, variable tensile, compressive and torsional forces may build a stronger biological scaffold which creates tissue resilience equipped to withstand a wider range of loading.

The use of activity in the recovery phase of back rehabilitation may either emphasise common actions built into a patient's lifestyle or be formed from specific exercise. Where exercise is used, it is commonly either general (whole body) or specific (spine related), and various components of fitness may be targeted to structure a programme as detailed elsewhere (Norris, 2008, 2012, 2015). Components of fitness may for convenience be categorized as ‘S’ factors (Table 6) and each action will involve an interplay between various components. Exercise may be selected to emphasise a particular component and increased or reduced in demand (exercise progression and regression). Demand is typically measured as exercise volume or dosage using the F.I.T.T mnemonic (Table 7).

Precision of movement can be important to avoid actions which exacerbate a patient's symptoms. Cueing is used to give feedback and enhance learning, and this may be visual (demonstration, mirror, video feedback), verbal (instructions, metaphor, tone of voice), tactile (touching, adjustment, mobilisation with movement), or cognitive (implicit meaning, visualisation). Close coaching places some of the responsibility for the movement outcome on the instructor, which is reassuring to the patient in phase 1 of the 3R's approach. Later in the programme (phase 2) coaching is gradually de-emphasised and then withdrawn (phase 3), to transfer responsibility for decision making onto the patient. Similarly, exercise tasks become less targeted, changing from *explicit meaning* (aim clearly stated, e.g. dumbbell shoulder press 2 sets of 10 reps with 10 kg weight) to *implicit meaning* (aim not clearly stated, e.g. place that weight on a high shelf). By reducing the focus of an exercise, variability is increased and decision making enhanced.

In many cases tissue damage may be minimal in LBP, and less emphasis should be placed on the bio- aspect of the BPS model and more on the psychosocial aspects. Exercise or activity is used earlier in these cases (sometimes from day one) partly for its analgesic effect, and to prevent kinesiophobia. Use of graded activity (progressive exercise) is commonplace in both wellness programmes and rehabilitation to produce overload and instigate tissue

**Table 6**
‘S’ factors of fitness.

| ‘S’ factor | Interpretation |
|---|---|
| Stamina | Cardiovascular and local muscle endurance |
| Suppleness | Range of motion, static and dynamic flexibility. Agility |
| Strength | Concentric/eccentric/isometric |
| Speed | Acceleration & deceleration/Power |
| Skill | Movement quality/sensorimotor training |
| Structure | Body composition/anthropometry |
| Spirit | Psychological fitness/psychosocial aspects of injury |
| Specificity | Task & sport related requirements |

(Adapted from Norris, 2017).

**Table 5**
Recovery phase — treatment aims.

- Progress from phase 1 when pain and/or fear no longer limits (able to walk 10 min and sit to stand 3–5 reps)
- Teach that movement and loading are good for the spine
- Progressive exercise (simple to compound increasing in complexity)
- Coaching to give feedback (tactile, auditory, visual)
- Decrease fear of movement — introduce variety and challenge beliefs (e.g. bending/lifting)
- Build patients confidence with static hold of heavy loads - Isometrics if positive effect on pain (self efficacy).
- Build ‘S’ factors related to patient requirements
- Implicit versus Explicit meaning of an exercise

**Table 7**
F.I.T.T mnemonic used in exercise prescription.

| F | FREQUENCY – How often |
|---|---|
| I | INTENSITY – How hard |
| T | TIME – How long |
| T | TYPE – How varied |

adaptation. However, if pain onset is used as a stop point rather than rating of perceived exertion (RPE) it may reinforce the perception that 'hurt equals harm' and encourage a belief that painful activity may result in damage to the back with a resultant exacerbation of suffering (Bunzli et al 2015; Lagerman, 2018). Using a time contingent approach rather than symptom contingent de-emphasises the focus on tissue and pain (Nils et al 2014). Use of training volume with the FITT mnemonic gives the opportunity to change several variables in addition to time to suit patient requirements. Use of exercise dosage in this way may be used to influence threat perception (Lagerman, 2018).

Two examples will be used to illustrate these principles. In the first example, 4-point kneeling is used as a supported position for the spine with minimal gravity effect. In the second example forward bending is used to challenge patient beliefs and increase functional capacity.

#### 4.2.1. Example 1

A 4-point kneeling starting position is used. This may be modified for patient comfort, using a pad beneath the knees, taking weight through an open fist or the forearms rather than an extended wrist, or by using lateral rotation at the shoulder to reduce the degree of wrist extension. The patient may be encouraged to explore the alignment of the spinal curves using a pelvic tilt (lumbar spine) and head position (cervical and thoracic spines), and neck side flexion coupled with hip hiking (whole spine side flexion) to challenge proprioception (image 1a/b). If pain occurs during movement, the exercise should continue to establish if pain reduces (stiffness) or increases (tissue irritability). In the reactive phase of 3R's back rehabilitation, exercise can be regressed (FITT changed) where pain is present. However, during the recovery phase movement should continue through the onset of pain to complete the action for the pre-agreed (patient agreed) exercise dosage.

In the starting position the body is supported by both upper and lower limbs as though it were a tabletop supported by four legs. Removing one limb support challenges the trunk muscles and places greater overload on the remaining limbs. Three progressions may be used. For progression one the shoulders are swayed to the left to off load the right arm, and the hand is lifted from the mat. Tactile cueing may initially be given to guide the movement quality and quantity. As movement skill improves, tactile cueing gives way to verbal cueing. Progression two raises the arm forwards along the mat keeping the fingers on the mat for balance, and progression three raises the straight arm to the horizontal position emphasises work on the shoulder and thoracic spine. Similarly, swaying the pelvis to unload one leg, raising one leg backwards along the mat with the toes on contact with the surface, the then lifting the leg horizontally emphasises work on the hip and lumbar spine. Combing contralateral arm and leg lifts (right arm/leg leg) challenges the trunk and limb musculature further (birddog or superman exercise)(image 2). Increasing repetitions and/or holding time, adding weight bag or band resistance, or performing the exercise on an unstable surface increase overload further (image 3).

#### 4.2.2. Example 2

A bending action is performed from different starting positions and to different movement ranges. Bending is included as it is often a feared movement in patients with LBP, partly because bending may have been involved in the initial driver of pain, but also importantly because it is a movement often demonised in public back care advice material. Bending is also an action which may be considered functional as it is typically involved in daily tasks and so is readily integrated into non-traditional exercise-based situations. Bending towards the floor involves a combination of spinal flexion with anterior pelvic tilt. Differentiating the two actions can be a useful tool for patient education. Initially hip hinge motions may be used to encourage pelvic motion, using both bent and straight knee positions to illustrate hamstring involvement (hip hinge action). Tactile cueing may be given using the therapists hands, or a pole placed along the length of the patient spine (image 4a&b). Although a useful isolation exercise, a hip hinge must not be allowed to reinforce a patient's belief that bending the spine can be dangerous. Progressing to spinal flexion is important, encouraging a relaxed forward bend to reinstate the flexion relaxation (FR)

**Image 2.** 4 point kneeling, alternate arm and leg lift.

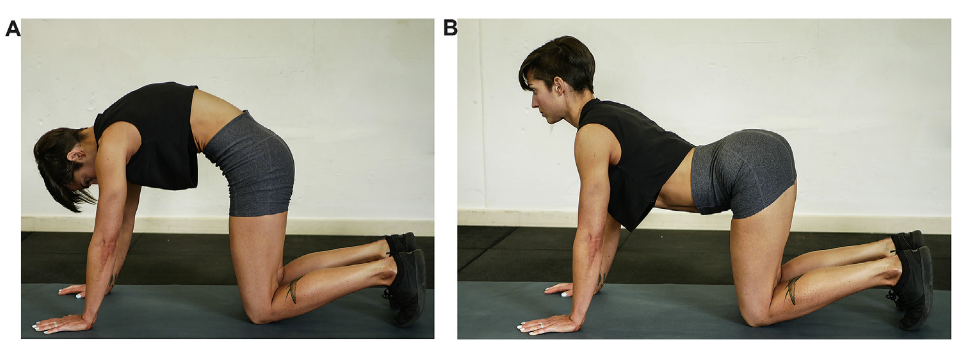


**Image 1.** 4 point kneeling (a) spinal flexion (b) extension.

**Image 3.** 4 point kneeling band resisted leg raise to horizontal.

response, often lost in those with chronic LBP (Pagé et al 2015; More et al 2015). Encouraging spinal flexion (Pilates roll down exercise or Jefferson curl) may be performed initially to high level onto a chair or gym bench, and gradually to lower levels and the floor (image 5). The emphasis should be to relax the musculature using the breath (avoid breath holding, encourage exhalation) to demonstrate the pain reducing value of allowing muscles to relax to reduce guarding. This bending action may then progress to lifting actions from the floor and deadlift type movements for athletes in the resilience stage of 3R's back rehabilitation.

Where patients are not able to perform structured exercise or are not motivated to do so, common daily actions may be modified to form rehabilitation tasks. Parking the car further from the workplace to encourage walking, reaching for higher shelves in a kitchen cabinet to encourage shoulder mobility and spinal extension, dog walking with increased distance and/or intensity, playing with the grandchildren are all examples of increased activity which challenge fitness and develop movement confidence. Again, time contingency or the FITT mnemonic rather than symptom contingency is used to establish dosage.

### 4.3. Resilience phase

Treatment aims for the resilience phase of the 3R's approach are shown in Table 8. Resilience or 'toughness' is the capacity to recover quickly from difficulties, or an individual's ability to return to a natural state of balance or homeostasis outlined above. In colloquial terms it is the ability to 'get back up when you are knocked down'. As with all phases of the 3R's approach, it can be viewed from a biopsychosocial viewpoint. Mental or emotional resilience has been said to have several factors; a positive attitude, optimism, the ability to regulate emotions, and the ability to see failure as helpful feedback (Psychologytoday.com, 2019). Physical resilience is the body's capacity to adapt to challenges or demands and to recovery effectively and will rely heavily on the 'S' factors of fitness. Social resilience reflects lifestyle factors such as a supportive network of family and friends, a good diet and adequate relaxation and sleep all supporting recovery.

Resilience is an important concept, because LBP is a condition which has been described as be over-treated (Deyo et al 2009). Pain is part of everyday life and does not necessarily indicate harm and should not automatically lead to suffering. Whilst an individual

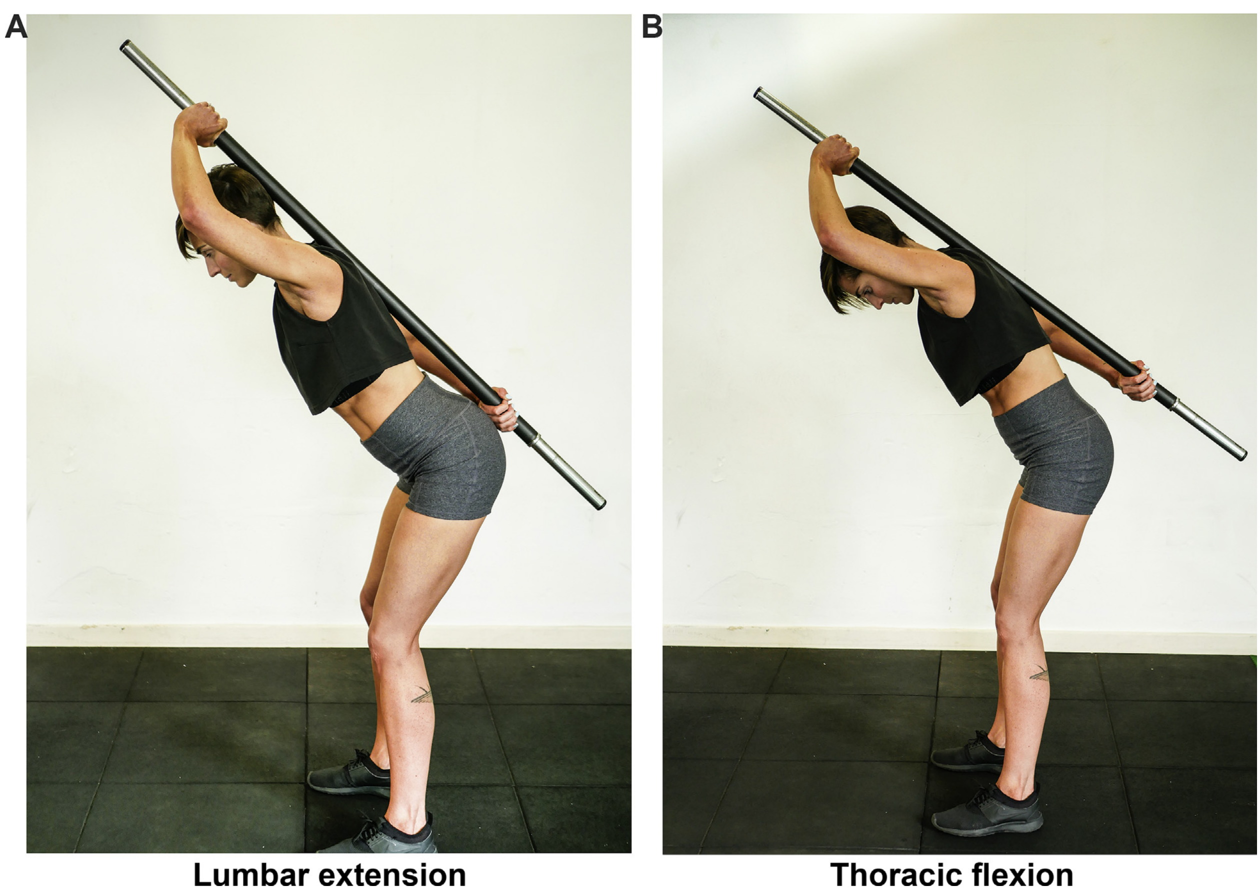


**Image 4.** Hip hinge action using pole (a) correct (b) incorrect.

**Image 5.** Roll down exercise to highchair

may seek treatment for pain in the low back after gardening, viewing the pain as negative (potential harm) they probably would not seek treatment for muscle pain following a gym workout, viewing this incident of pain as positive (sign of a good workout).

Within the 3R's back rehabilitation approach, the resilience phase is the final stage of a progression of graded activity and graded exposure. Throughout the recovery phase, physical capacity has been redeveloped and should by now exceed pre-injury levels, and the individual will have built confidence and optimism in movement. These abilities are now increased with whole body challenging tasks.

Throughout the 3R's progression, movement (motor) and knowledge of this movement (sensory) are combined leading to sensorimotor training. In the early stages there is less emphasis on this combination, and in the later stages more. Sensorimotor training combines general control of the whole body with specific control of individual bodyparts. Actions fuse aspects of free movement (mobility) and stiffness (stability), and considerable variation will occur between patients. Initially, variation may be reduced where a style of performing an action drives symptoms. As we progress to the resilience phase of the 3R's approach, movement variability is encouraged as it gives patients a greater number of movements to select from, increasing the likelihood of optimising the action for each individual.

In the resilience phase of the 3R's approach, the complex actions used can mimic requirements of a task which the patient is hesitant to do as a result of their injury. In so doing they may be termed functional or task specific. In addition, phase 3 exercises may simply increase overload to take selected fitness ‘S’ factors to a higher level. Strength should be increased with a variety of exercises to load a bodypart in different ways to increase movement variability. For example, a barbell shoulder press action (resisted overhead reach) used in the phase 2 (recovery) may be performed with a light weight to limited range and in a seated position to reduce coordination demands and decrease body sway. The same action type in phase 3 (resilience) would be performed with a higher resistance, in standing to increase demands of both strength and coordination. Variation would be added by using unilateral (dumbbell) rather than bilateral (barbell) actions, both behind the neck (press behind neck) and in front of the head (military press). Strength can be progressed to speed (rate of movement) and power (rate of doing work). Overhead ball throwing (single or double handed) can be progressed to a medicine ball throw against a wall (predictable environment) and then into the air (less predictable environment), and finally with the action performed on an unstable base.

Predictability of the environment is an important consideration in motor skill training (Table 9), with a closed skill performed in a predictable environment and an open skill performed in an unpredictable environment. Skill training may also be varied by altering movement organisation. A single standalone action (isolated) requires close focus and so aids learning. Performing multiple repetitions of the action (repeated) builds familiarity, but focus is not as close due to fatigue and the possibility of distraction. A cycle of the same actions (continuous) reduces attention demand and moves the action towards becoming automatic (autonomous stage of motor learning).

Decision making is also an important consideration. In early rehabilitation (phase 2) coaching is used extensively to identify unwanted actions and motivate the patient, and give cueing (tactile, verbal, visual). However, close coaching partially shifts responsibility for the action onto the instructor. Requiring the patient to make decisions shifts responsibility for outcomes back to the patient in phase 3 (resilience), and so coaching is reduced. Decision making requires analysis of the problem. For example, in a ball catching movement, the patient must analyse to determine where the ball is going to appear (high, low, to the side etc) and then explore options (where should I stand to ensure a catch, where should I put my hands). Once decisions are required, one must be chosen (picking the best option), and sometimes this will be right and sometime not. Over time, the patient learns which actions are more likely to give a positive result.

The following examples are of resilience-based tasks for phase 3.

**Table 8**
Resilience phase — treatment aims.

- Progress from phase 2 when pain free and/or returned to typical daily function
- Improve exercise variability while increasing movement confidence, and reducing coaching
- Increase physical capacity and enhance function further using ‘S’ factors
- Improve full body conditioning — lifting, pushing, pulling, jumping, COD drills
- Exercises specific to functional requirements of patient — lifestyle/work/sport.
- Challenge subject by introducing variation of environment, movement complexity, apparatus, and decision making

(COD — change of direction).

#### 4.3.1. *Example 3*

Manual handling is often an action which can give rise to back pain, and this combined with sometimes outdated back pain prevention advice can make it an action approached with caution. Example 3 is a lifting and moving task combining several actions.

**Table 9**
Classifying skills.

| | | | |
|---|---|---|---|
| Movement organisation | | | |
| Discrete | Serial | | Continuous |
| Definite start and finish | Number of discrete actions linked | | No definite start or finish |
| Mental or Physical involvement | | | |
| Motor | | Cognitive | |
| Less decision making | | More decision making | |
| Influence of environment | | | |
| Closed | | Open | |
| Predictable environment | | Unpredictable environment | |

(from Norris, 2013).

The patient begins standing in front of a heavy bag or weight (core bag or medicine ball). They lift from the floor and turn to the right, carry the bag 5–10 paces and place it onto the shoulder high shelf (image 6). They pause, and then reverse the action taking the bag from the high shelf, turning, carrying, and then placing the bag back onto the floor. Initially this action is predictable (turn to the right on the first rep, to the left on the second) and performed at slow speed (walking pace). Predictability is reduced by the instructor calling out the direction of turn and timing the action to target speed. Different heights of lift (step bench/gym bench/high stool), weights, and weight shapes (sandbag with movement contents, asymmetric shape), and surfaces (gym mat/low hurdle to step over) may also be used to increase task variability.

**Image 6.** Bag lift and carry.

*4.3.2. Example 4*

This is a deadlift action which progresses from the recovery phase (example 2) to build strength in the hip and spinal musculature while at the same time working on a coordinated action, and building confidence to lift from the floor. The deadlift is a classical compound (whole body) exercise seen in many gyms (image 7a). The traditional action begins with an Olympic barbell placed in front of the patient, the bar at mid shin level. Feet are hip width apart and turned out slightly, and the action is to bend the legs (ankles, knees, hips) keeping the back straight and to grip the bar. By standing up, the bar is lifted from the floor in a vertical path (keeping it close to the body) using the strength of the lower body to generate power to lift and of the upper body to provide the stability to hold the bar at mid-thigh level at the top of the lift.

As well as increasing overall strength (especially lower body strength) the deadlift rehearses a coordinated action between the legs, pelvis and low back while keeping the load close to the body posture line.

The classical movement may be modified in several ways (image7b). The bar may be placed higher or lower, dumbbells may be used in favour of a barbell to position the load to the side of the body rather than in front. A single kettlebell or medicine ball may be used to lift from a position closer to the floor and/or to increase the speed of movement. A deadlift frame (Shrug or Hex bar) may be used with the patient standing inside the frame and gripping in a sagittal plane rather than the frontal plane grip used in the classical bar lift. The speed of the classical lift may be increased (strength training progressing to power work) to perform a power clean, or a medicine ball may be lifted from the floor and thrown towards a wall or training partner.

## 5. Discussion

The 3R's approach to back rehabilitation represents a structured care pathway incorporating pain management, patient education, and physical conditioning. It aims to present holistic therapeutic management within a biopsychosocial framework. As such the emphasis is on whole person management rather than tissue specific treatment. The three phases of the 3R's approach (reactive, recovery, resilience) represent a progression which is both temporal and functional. As healing progresses, pain and inflammation subside and recovery ensues with patients typically returning to some level of function. However, the nature of LBP is such that function is often reduced and recurrence of symptoms typical. The 3R's approach aims to increase a patient's capacity to improve function and lessen the likelihood of recurrence.

Patients may enter the 3R's pathway at various stages. Those with a recent injury or pain onset will naturally enter at phase 1

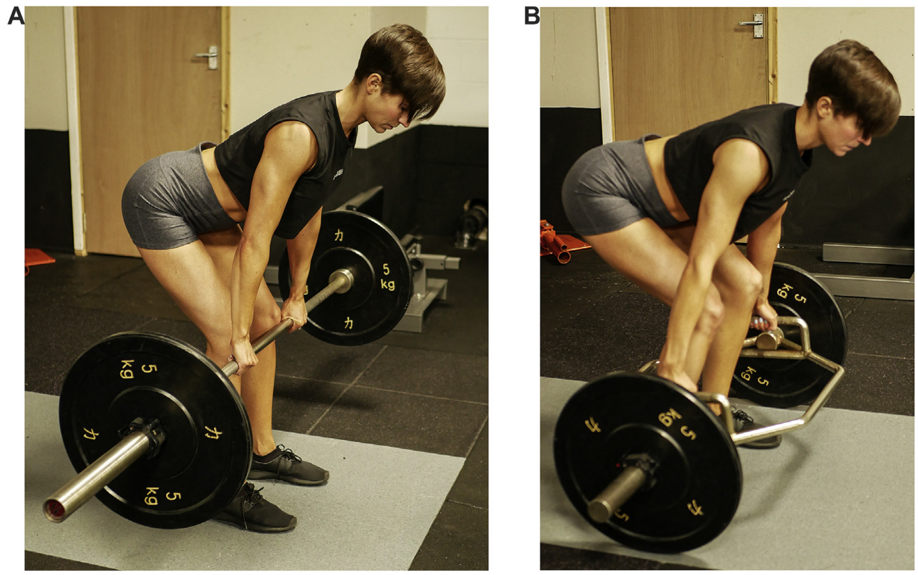


**Image 7.** Deadlift action (a) classical (b) modified.

(reactive). However, those with a history of recurring LBP may enter at stage 2 (recovery) where deconditioning is a driver of their condition, or at stage 3 (resilience) where kinesiophobia is present in the absence of significant other symptoms. It is important that patients progress to the final stages of the 3R's approach, as failure to do so may leave them open to re-injury. Relieving pain in stage 1 without engaging in physical activity, or conditioning the back tissues in stage 2 without building confidence in movement variation, can leave a patient at risk of recurrence and the development of chronicity. The 3R's approach attempts to improve patient care by combining the skills of therapists and exercise professionals.

## Clinical relevance

- This article provides evidence-based knowledge on the rehabilitation of low back pain
- The 3R's approach to back rehabilitation presented is a patient targeted method of progressive rehabilitation constructed on a biopsychosocial model.
- The rehabilitation approach is multimodal and crosses professional boundaries linking the therapy and exercise professions.

## Declaration

No financial assistance has been received in the preparation of this manuscript.

## References

Babatunde, O.O., Jordan, J.L., Van der Windt, et al., 2017. Effective treatment options for musculoskeletal pain in primary care: a systematic overview of current evidence. PLoS One (6), 12. Jun 22.
Bardin, L.D., King, P., Maher, C.G., 2017. Diagnostic triage for low back pain: a practical approach for primary care. Med. J. Aust. 206 (6), 268–273.
Bunzli, S., Smith, A., Watkins, R., et al., 2015. Do people who score highly on the tampa scale of kinesiophobia really believe? A mixed methods investigation in people with chronic nonspecific low back pain. Clin J Pain. Jul 31 (7), 621–632.
Cook, J.L., Docking, S.I., 2015. Rehabilitation will increase the ‘capacity’ of your … insert musculoskeletal tissue here…” Defining ‘tissue capacity’: a core concept for clinicians. Br. J. Sports Med. 49, 1484–1485.
da Silva, T., Mills, K., Brown, B.T., et al., 2019. Recurrence of low back pain is common: a prospective inception cohort study. J. Physiother. 65 (3), 159–165.
Deyo, R.A., Mirza, S.K., Turner, J.A., et al., 2009. Overtreating chronic back pain: time to back off? The Journal of the American Board of Family Medicine Jan 22 (1), 62–68.
Dye, S., 2005. The pathophysiology of patellofemoral pain – a tissue homeostasis perspective. Clin. Orthop. Relat. Res. 436, 100–110.
Engel, G.L., 1977. The need for a new medical model: a challenge for biomedicine. Science 196 (4286), 129–136.
Foster, N.E., Hill, J.C., O'Sullivan, P.B., et al., 2015. Stratified models of care for low back pain. In: WCPT Congress Singapore, May.
Glasgow, P., Phillips, N., Bleakley, C., 2015. Optimal loading: key variables and mechanisms. Br. J. Sports Med. 49, 278–279.
Hill, J., et al., 2011. A randomised controlled trial and economic evaluation of stratified primary care management for low back pain compared with current best practice: the STarT Back trial. Lancet 378 (9802), 1560–1571. https://www.psychologytoday.com/gb/basics/resilience. (Accessed September 2019).
Hurwitz, E.L., Randhawa, K., Yu, H., et al., 2018. The global spine care initiative: a summary of the global burden of low back and neck pain studies. Eur. Spine J. 27, 796–801, 2018.
Khan, K.M., Scott, A., 2009. Mechanotherapy: how physical therapists' prescription of exercise promotes tissue repair. Br. J. Sports Med. 43 (4), 247–251.
Lagerman, P., 2018. Reasoning Exercise Dosage for People with Persistent Pain, pp. 30–35. In Touch No. 164 Autumn.
López-de-Uralde-Villanueva, I., Muñoz-García, D., Gil-Martínez, A., et al., 2016. A systematic review and meta-analysis on the effectiveness of graded activity and graded exposure for chronic nonspecific low back pain. Pain Med. 17, 172–188.
Low, M., 2018. Managing Complexity in Musculoskeletal Conditions, pp. 22–29. InTouch. No 164. Autumn.
Malfliet, A., Ickmans, K., Huysmans, E., et al., 2019. Best evidence rehabilitation for chronic pain Part 3: low back pain. J. Clin. Med. 19 (7), 8 pii: E1063.
Malfliet, A., Kregel, J., Coppieters, I., et al., 2018. Effect of pain neuroscience education combined with cognition-targeted motor control training on chronic spinal pain: a randomized clinical trial. JAMA Neurol 75, 808–817.
Melzack, R., 1990. Phantom limbs and the concept of a neuromatrix. Trends Neurosci. 13, 88–92.
Meucci, R.D., Fassa, A.G., Faria, N.M., 2015. Prevalence of chronic low back pain: systematic review. Rev. Saude Publica 49, 73.
Monticone, M., Ferrante, S., Rocca, B., et al., 2013. Long-lasting multidisciplinary program on disability and fear-avoidance behaviors in patients with chronic low back pain: results of a randomized controlled trial. Clin. J. Pain 29, 929–938.
Moore, A., Mannion, J., Moran, R.W., 2015. The efficacy of surface electromyographic biofeedback assisted stretching for the treatment of chronic low back pain: a case series. J. Bodyw. Mov. Ther. 19 (1), 8–16.
National Institute for Health and Care Excellence, 2016. Nice Guidelines: Low Back Pain and Sciatica in over 16s: Assessment and Management. National Institute for Health and Care Excellence, London, UK.
Nijs, J., Meeus, M., Cagnie, B., et al., 2014. A modern neuroscience approach to chronic spinal pain: combining pain neuroscience education with cognition-targeted motor control training. Phys Ther. May 94 (5), 730–738.
Norris, C.M., 2008. Back Stability (2nd Ed) Integrating Science and Therapy. Human Kinetics, Champaign, Illinois. USA.
Norris, C.M., 2012. Exercise Therapy Basics, pp. 2–6. In Touch, 140 (Autumn).
Norris, C.M., 2013. The Complete Guide to Exercise Therapy. Bloomsbury.

Norris, C.M., 2015. The Complete Guide to Back Rehabilitation. Bloomsbury.

Norris, C.M., 2017. Injury, Tissue Capacity and Load Management, pp. 10–15. In Touch. Spring (edition 158).

Norris, C.M., 2019. Sports and Soft Tissue Injuries. Routledge, London.

O'Connell, N.E., Cook, C.E., Wand, B.M., et al., 2016. Clinical guidelines for low back pain: a critical review of consensus and inconsistencies across three major guidelines. Best Pract. Res. Clin. Rheumatol. 30, 968–980.

O'Keeffe, M., Purtill, H., Kennedy, N., et al., 2015. Individualised cognitive functional therapy compared with a combined exercise and pain education class for patients with non-specific chronic low back pain: study protocol for a multicentre randomised controlled trial. BMJ Open 5, e007156.

O'Sullivan, P., 2017. Making sense of back pain: A cognitive functional approach. In: Course notes. Royal Free Hospital, London.

Oliveira, C., Maher, C.G., Pinto, R.Z., et al., 2018. Clinical practice guidelines for the management of non-specific low back pain in primary care: an updated overview. Eur. Spine J. 27, 1–14.

Pagé, I., Marchand, A., Nougarou, F., et al., 2015. Neuromechanical responses after biofeedback training in participants with chronic low back pain: an experimental cohort study. J. Manip. Physiol. Ther. 38, 449–457.

Roche-Leboucher, G., Petit-Lemanac'h, A., Bontoux, L., et al., 2011. Multidisciplinary intensive functional restoration versus outpatient Active physiotherapy in chronic low back pain: a andomized controlled trial. Spine 36, 2235–2242.

Setchell, J., Costa, N., Ferreira, M., et al., 2019. What decreases low back pain? A qualitative study of patient perspectives. Scand J Pain 26 (19), 597–603, 3.

Sowden, G., Hill, J.C., Morso, L., et al., 2018. Advancing practice for back pain through stratified care (STarT Back). Braz. J. Phys. Ther. 22 (4), 255–264.

Steiger, F., Wirth, B., de Bruin, E.D., et al., 2012. Is a positive clinical outcome after exercise therapy for chronic non-specific low back pain contingent upon a corresponding improvement in the targeted aspect(S) of performance? A systematic review. Eur. Spine J. 21, 575–598.

Tousignant-Laflamme, Y., Martel, M.O., Joshi, A.B., et al., 2017. Rehabilitation management of low back pain - it's time to pull it all together! J. Pain Res. 10, 2373–2385. Oct 3.

Vanti, C., Andreatta, S., Borghi, S., et al., 2019. The effectiveness of walking versus exercise on pain and function in chronic low back pain: a systematic review and meta-analysis of randomized trials. Disabil. Rehabil. 41, 622–632.

Wade, D.T., Halligan, P.W., 2017. The biopsychosocial model of illness: a model whose time has come. Clin. Rehabil. 31 (8), 995–1004.