Pomeranian J Life Sci 2021;67(3):55-65 doi: 10.21164/pomjlifesci.556

Low back pain in disorders of the intervertebral disc – bio-psycho--social conditions

Maciej Chrzanowski ✉

Jan Korczak Provincial Specialised Hospital in Slupsk, Hubalczyków 1, 76-200 Słupsk, Poland

[A] ORCID: 0000-0001-6007-654X

✉ carox@gazeta.pl

ABSTRACT

Low back pain is a very common health problem affecting about 80% of the global population and has an impact on biomedical, psychological and sociological areas. There are many types of treatment centered around evidence-based practice. This paper tries to present most of the therapeutic methods used to ease pain and improve the quality of life. Manual therapy, core exercises, dry needling, kinesiotaping and transcutaneous electrical nerve stimulation have different efficacies and result in treating and managing pain. It could be quite certain to indicate a superiority of manual therapy and core exercises over the rest of evaluated methods. This article demonstrates examples of core exercises that in some cases may be useful to help with low back pain.

Keywords: pain management; low back pain; TENS; dry needling; manual therapy; kinesiotaping; kinesiophobia; core exercises.

INTRODUCTION

Low back pain (LBP) is a medical condition that affects about 80% of the global population. It is estimated that in any given month, 23% of the global population experiences LBP [82]. In some cases, the pain occurs even more often – such as in a group of dentists where it was found that up to 90% have such a condition [1]. Untreated LBP can become a chronic disease [2] and even lead to disability [3]. Despite the difficulties associated with living in pain and the limitations this invokes, in the long term, this may lead to the development of 'motor compensation' which burdens the knee, hip or ankle joint and can lead to dysfunction [4]. When we talk about chronic pain, it is important to be aware of its interaction with cognitive, proprioceptive, emotional, cultural and contextual factors. Wojtyna noticed that people learn how to express the sensation of pain. Therefore, the type of behavior that occurs as a follow-up to an injury often depends on the interpretation of the incident and prior pain reactions developed in early oncogenic stages [5]. Although the etiology, duration and nature of pain varies, there are risk factors that increase the likelihood of LBP. It is assumed that females are more likely to be affected with LBP [6]. This is most likely related to a higher prevalence of osteoporosis in females, a faster growth rate during adolescence and a connection to menstrual pain [7].

Incidences of LBP increase with age. Pain is most common during late adulthood, especially between the ages of 60–65 [8] (Fig. 1). Due to the wide range and prevalence of LBP, about 500 studies have been performed to determine the most efficient methods of treatment. Scientists attempt to find the best way to deal with LBP through evidence based practice and clinical records. New standards and systems are continually created to facilitate proper decision making by medical practitioners, depending on the medical condition of the patient. However, the question remains: what are the most common causes of LBP and what are the possibilities to professional overcome pain or efficient self-help activities? This review is an attempt to comment on the presented topic of LBP with additional exercise recommendations.

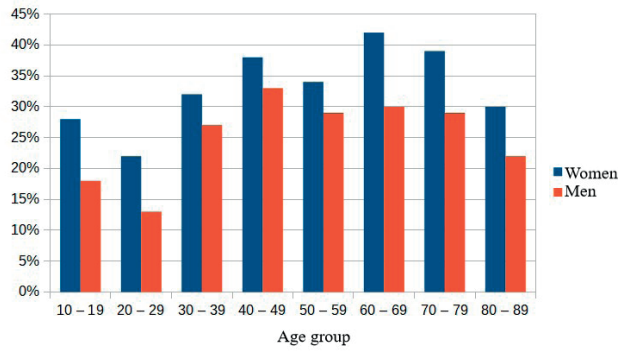

FIGURE 1. Prevalence of low back pain [9]

THE MECHANISMS OF PAIN

Pain may have an episodic character that can relive just after it occurs. It can also occur for a longer period of time – weeks, months, years or can even be a lifelong condition (Fig. 2).

CC BY NC ND

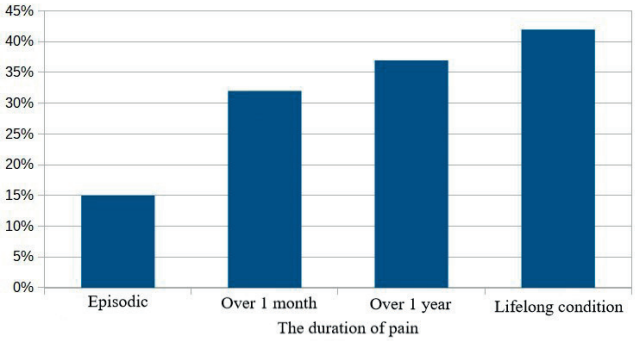

FIGURE 2. Length of time low back pain can last [9]

There are many causes of LBP, and many different methods of treatment. The origin of pain may be an intervertebral disc with an incorrect anatomical structure or disorders from structures such as vertebral bodies, intervertebral articles, meninges, or spinal nerves. Such abnormalities may be a result of degenerative factors, Scheuermann's disease, rheumatoid diseases, fractures, injury or tumor [10, 11]. Due to a wide range of aetiologies, a proper diagnosis of the cause of pain and choosing the right treatment is difficult and requires experience. It should be mentioned that even if the classification of LBP is widely known, mistakes are made quite often. In many clinical standards, LBP differentiates between 3 major groups: nonspecific pain without radiculopathy symptoms, pain with radiculopathy symptoms and pain connected to the spinal cord [12]. Clinical standards use a definition of "red flags" that refers to disorders such as: cauda equina syndrome, spinal fractures, tumors, aortic aneurysm, spondylarthritis, gastrointestinal or genitourinary diseases. All of the above can cause LBP and treating them without proper diagnosis is dangerous and as such, requires consultation with a specialist. Clinical standards specify that disorders such as cauda equina syndrome or aortic aneurysm require immediate medical intervention in an intensive care unit. If a patient has a fever with a temperature above 38°C lasting for at least 48 h and presents symptoms such as paresis, paralysis or lateralization of pain, they require urgent consultation within 24 h. Optimistically, about 85–95% of patients with LBP don't have red flags and therapeutic treatment can be implemented. About 2% of patients have a pain connected to gastrointestinal or genitourinary diseases and about 3% are connected to fractures. Ankylosing spondylitis or aortic aneurysm is found in less than 1% of cases [13]. Within the context of the above findings, "yellow flags" are also classified. Yellow flags are connected to mental illnesses, socioeconomic deficiency and fear of treatment or movement (kinesiophobia). These symptoms can result in a false clinical picture, as there is a risk that the prevalence or absence of symptoms can be simulated [14].

One of the most common causes of LBP is a degenerative intervertebral disc. Intervertebral discs are structures about 7–10 mm high and 4 cm wide that provide resistance to axial compression and allow slight movements of the spine. Nucleus pulposus is located in the internal part of the disk. It is built by a gel-like substance which consists mainly of proteoglycans, water and disorganized arranged type II collagen flattened by cartilage endplates [15]. The external part of the intervertebral disc is called the annulus fibrosus, built by 15–25 concentrically arranged laminas around the nucleus pulposus. Laminas are built by type I collagen arranged at an angle of 60 degrees from the axial line [16]. During the process of disc degeneration, the disc flattens and numerous grooves and fissures develop, the amount of water decreases, and cells undergo multiple morphotic changes like cell proliferation or necrosis [17]. Such changes induce pain, decrease the ability to resist compression, weaken muscles, and exacerbates radiculopathy symptoms during movement or change of position [18]. Degenerative disc disorder may be caused by genetic factors, socioeconomic deficiency or can be connected to involution processes [19]. Work satisfaction, interpersonal contacts, mental overload and stress are also connected to LBP. Pain can change cognitive efficiency and the behavior of a patient. Negative thoughts, a decrease or complete avoidance of physical activity as a result of a fear of pain escalation, hyperactivity and depression are common [20]. Pain development is connected to obesity, hard work, presence of pain in the past, and preferred forms of recreation [21]. The endurance to compression in a healthy intervertebral disc is in the range of 3,000–10,000 Newtons, and if these values are exceeded, it may cause a disc injury. It was observed that disc injury occurs after 1,000–2,000 repetitions of 37–50% of max. load, or after just 100 repetitions of 50–80% of max. load [22]. Degeneration or protrusion of an intervertebral disc may result in muscle weakness, sensory loss or distortion of the autonomic nervous system [23]. The approachability of chronic LBP is strongly correlated with the disc degeneration rate as defined by Pfirmann's scale [24].

Intervertebral discs, zygapophysial joints and the sacroiliac joint may cause LBP. Each of the above structures is richly supplied with nerves that can be both mechanically and chemically stimulated. There are no clear methods to fully differentiate the cause of LBP. Injections of anesthetic or stimulation substances can be administered to determine which structure is in pain, unfortunately such actions are invasive and expensive. The procedure of choice is generally to perform some clinical tests. Magnetic resonance imaging (MRI) is a diagnostic tool that can verify if an intervertebral disc is a cause of pain. It can be observed in a highly intensive sphere, rich in water fractured annulus fibrosus. White intensive spots of disc degeneration are defined as endplates, which has cartilage origin that in time undergoes ossification. They are usually less than 1 mm thick and are located on the cranial and caudal side of the disc. The most common endplate deformities are Schmorl's nodes, seen as a bulge of disc nucleus into the body of adjacent vertebrae. A single manual test on a sacroiliac joint is not clinically significant, but if multiple tests are performed, the source of pain in the sacroiliac joint can be verified. There is no single clinical test to correctly verify if zygapophysial joints are a source of pain, so using such tests may be invalid [25, 26, 27].

PSYCHOLOGICAL APPROACH TO PAIN

The neurobiological mechanisms of LBP recovery remain mostly misunderstood and progress towards the effective management of pain is limited due to the complexity of the topic and multidisciplinary approach by specialists such as biomechanics, geneticists, neuroanatomists, physiologists, physicians, physiotherapists, psychologists, psychiatrists, sociologists. A multidisciplinary approach is often limited by culture, economic and geographic factors [28]. From a psychological point of view, pain is described as a feeling of an unpleasant real-time experience in response to a threatening stimulus that may lead to tissue injury. This sensation is endured individually based on past experiences in a subjective way on many levels [29]. Pain makes diagnosis difficult as the patient may experience fear and depression as a result of an existence limited by illness. Patients have a tendency to avoid contact with medical personnel and usually do not cooperate. Catastrophizing pain is also common in intervertebral disc disorder. Due to negative thoughts, the feeling of pain is over-evaluated [30]. The suffering of patients, especially in the long-term, has a negative impact on their quality of life. Therefore, pain management is a top priority in LBP. Pain can be resistant or unresponsive to medication and can persist even after healing. To increase the odds of a good treatment, a combined approach using different healthcare professionals is required. This includes psychiatrists, physiotherapists, psychologists and occupational therapists [31]. The intensity, severity, location, duration and distribution of pain must be considered during assessment and there are many tools like Visual Analogue Scale, the McGill Pain Questionnaire and the 4-Item Pain Intensity Measure used to confirm a subjective report [32]. One of the most influential behavioral pain models in clinical pain psychology is the fear-avoidance model (FAM). Patients have a tendency to partake in various pain avoidance behaviors across their lifespan which may increase the risk of disability and chronic conditions with the most common being limiting movement. As a result of pain, most people have an unpleasant feeling and are in discomfort. This feeling does not usually threaten their well-being. Usually, appropriate behavior results in movement restriction and a gradual increase in activity until the patient has recovered. However, in some people pain indicates a serious threat to their well-being resulting in a self-propelling cycle of catastrophizing pain. Such behavior results in limiting activity beyond the expected time of normal healing. Appropriate treatment targeting avoidance behaviors and pain-related fear may be a good preventative strategy [33]. The FAM neglects the role of socially oriented goals and motivational factors [34].

The bio-psycho-social (BPS) model is a far more complex concept than the FAM and suggests that a person's medical condition in not only understood by his or her biological factors, but has to be considered also by the psychological (cognition, behavior, mood) and social (cultural) factors. This is in opposition to the criticized biomedical model which cannot explain the complexities of pain experience [35]. Moreover, chronic pain cannot be categorized in one of those categories of factors alone, but it is a component of each category – therefore potential treatment should address them all [36]. In the BPS model all factors interact and overlap between each of these categories without any clear division [37]. Most well-known studies suggest that all factors of the BPS model are important, however, the majority of them largely focus on the biomedical aspects [38]. Emotional distress has a strong association with chronic pain and interferes with daily activities. The patients experience of pain may be real regardless of a lack of any physical cause. Such pain is described as "medically unexplained" or "psychosomatic". For patients, the suffering is real, but a wide range of possible causes must be considered, especially in psychological and social factors [39]. In the BPS model, the main focus is not on the disease but on the illness which is viewed as a type of behavior. Illness behavior is a dynamic process that may differ in perception by individuals with different sensations as a result of pain, discomfort or injury and may result in different outcomes of daily activity levels [32]. A framework of psychosocial flags was proposed to indicate if someone requires additional support and may not recover as expected. These flags are referred as the obstacles to recovery. Yellow flags are obstacles that include aspects of thoughts, feelings and behaviors of a person to manage his or her situation. Blue flags concern the workplace and perceptions of health and work – like job satisfaction, ability to cope with job expectations, proper communication and support at work. Black flags are connected to the person's environment and include other people, family, health system and policies [40]. Common examples of yellow flags are: a fear of movement, thinking the worst – catastrophizing with visualizations of reinjury, reporting disproportionate amounts of pain for the severity of the condition, being distressed or low in mood and overall uncertainty about the future. It is also a yellow flag if a patient seeks help from various practitioners and expects to hear a desired diagnosis while being passive in the recovery process with no visible effect. Despite all of the above obstacles it has been shown that positive thinking and optimism has a positive impact on functioning through pain and provides an overall sense of well-being [41].

SOCIOLOGY OF PAIN

From the sociological point of view, family – especially spouses, friends and significant family members – have a high influence on the pain experience. Being in pain usually garners attention and sympathy in social environments. This may result in changes to the patient's behavior to avoid responsibilities and undesired activities. However, the role of the family in maintaining both a positive and negative influence on the patient's recovery is significant [42]. Social isolation from physical activities and friends is an obstacle to recovery

from LBP, especially when the LBP is untreated [43]. Socioeconomic status and educational levels result in different coping strategies to deal with pain. People that are homeless or illiterate have difficulties in reaching primary health care and use self-applied ineffective pain coping strategies that often result in pain becoming a chronic condition. As well as this, a low income is usually connected to physically-demanding work (long hours, fatigue, repetitive tasks) with biomechanical difficulties (forced position and bad posture) and lack of support if a painful accident occurs [44]. Geographic, cultural and political circumstances can result in inequitable access to healthcare. All over the world there are different healthcare systems that have different patient rights, insurance costs, availability of specialists and advanced medical procedures. In many cultures, solutions to ease pain are vastly different and the perception of pain is represented through language. For example, Latin Americans differentiate a headache from a brain pain and even treat them differently [45]. Moreover, in most cultures, women experience different pain responses and seek medical help more often than man. It may be a result of a fact that women are at greater risk to develop LBP [46]. An individual hierarchy of values, experience of pain and its awareness results in different emotional intensities of sorrow, sadness and anger [47]. It has also been shown that having high cognitive skills leads to a more effective and persistent recovery from pain [48].

METHODS OF PAIN REDUCTION

In the case of acute pain, the usual course of action consists of frequent rest, a change of physical activities or amending bad posture [49]. In order to determine the source of pain, medical history is collected where the medical practitioner gathers information about the duration, location and severity of the pain. The duration indicates the type of pain; if it persists for less than 4 weeks – the pain is acute, if the pain lasts between 4 weeks and 3 months – the pain is subacute, or if it lasts longer than 3 months – the pain is chronic. The location of the pain indicates the spinal section and can be single cervical, thoracic, lumbar, sacral or coccyx part, or several parts simultaneously. The severity of pain is measured by the VAS or the Laitinen questionnaire. The medical history verifies somatomotor deficiencies and risk factorss (old age, obesity, occupation, BMI, prevalent diseases or injuries). Scales to individually evaluate the character of the pain and dysfunctions or disabilities related to the pain can be applied. An example of such a scale is the Roland–Morris lower back pain questionnaire, which consist of 24 questions about everyday activities like walking, standing up, household chores, frequency of pain or, if there are some motor limitations, the cause of pain. The answers can be yes or no and more positive answers result in higher motor limitations [50]. A similar scale is the pain catastrophizing scale which focuses on 3 categories: how often the patient thinks about pain, how often he imagines a worsening of symptoms, and how often he feels helplessness to pain [51].

There are also tools to define if the sensation of pain changes after the implementation of therapy – like the Oswestry disability index questionnaire. This questionnaire quickly evaluates the degree of dysfunction in people with LBP by asking how well the patient can cope with lifting weights and maintaining their hygiene, social and sexual life [52]. The minimal clinically important change score reflects changes in clinical interventions that are meaningful for the patient and can be useful to evaluate collected data and plan further studies. It has some advantage over p value, which can make data statistically invalid if the variation is less than 5% [53]. Laboratory tests and diagnostic imaging (MRI, computed tomography scan, X-rays – both with or without contrast) can also be helpful. From the clinical point of view, LBP is mostly a result of radiculopathy – the spinal nerve compression by herniated disc, hematoma or inflammation. Other types of pain are associated with the spinal cord (injury, tumor) or when pain is nonspecific like in the case of muscle strain [54]. During examination, medical practitioners use the Lovett scale to make sure there is no muscle weakness. To have a better clinical view, measurements of the body are taken (hip circumference, leg length), reflexes and functional tests are performed [55].

In order to reduce pain, the 1st choice is usually nonsteroidal anti-inflammatory drugs physiotherapy and manual therapy. If the pain is a result of a sudden overload, heavy lifting, bad work ergonomics or mechanical injury, it is more important to reduce inflammation [56]. If therapeutic action is administered quickly after the incident, it can reduce pain noticeably and measurably. Manual therapy is physical treatment for musculoskeletal pain and disability that includes manipulations (rapid mobilizations), mobilization (improves range of motion in joints), neuromobilization (improves nerve slide to reduce compression) and stretching. It was found that only 1 patient per 3.7 million worsens their symptoms through manipulation [57]. It must be noted that even manual therapy has proven its effectiveness, results for the same population can be extremely different. For some, it brings total relief from pain, for others there are no effects at all [58]. In a study conducted on fighter pilots, 3 sessions of manual therapy were performed. It resulted in up to an 80% pain reduction enabling pilots to return back to work [59]. It can be presumed that pain reduction is partly due to the placebo effect. In another study, it was observed that after 12 weeks of manual therapy treatment, 63% of participants felt pain relief; however, 46% of participants felt pain relief after placebo therapy was performed [60]. In this study the effectiveness of ultrasound therapy was measured on the assumption that it accelerates collagen synthesis, repairs damaged tissues, and reduces swelling and pain [61]. Results have shown that after ultrasound therapy 44% of participants felt well. Unfortunately, 41% felt better after placebo, so the results were too unsignificant to treat ultrasound as a method of pain reduction in LBP [60].

Physiotherapy and rehabilitation improve the health aspect of the quality of life both in managing pain and it is physical consequences. However, in studies, there are often no statistically significant differences between the study and control group [62]. Diathermy, ultrasounds, cryotherapy and transcutaneous electric nerve stimulation (TENS) are in use for the treatment of chronic pain, but in the case of sudden events like a fall from a height, a car accident or a severe chronic disease such as cancer or neurological deficits, usage of such therapies is limited. The degenerative process of an intervertebral disc is usually irreversible, so the role of therapy is to reduce pain and change movement habits [63].

Transcutaneous electric nerve stimulation was studied to see if it was relevant in the reduction of LBP. This therapy relies on using electric impulses of low amplitude on peripheral nerves using Melzack's gates that prefer faster external signal than slower nerve fibers that transports information of pain. If we measure the effects of TENS just after it has been conducted, the benefits are indisputable. However, it only lasts for a short period of time and, to maintain pain reduction, a few sessions are required. The effectiveness of therapeutic methods are what medical practitioners are looking for and TENS therapy fulfills this role [64]. The study has shown that 84% of patients who underwent TENS therapy stopped taking analgesics [65]. Reduction of pain is not only in place of application but effects are felt overall. In case that intensively of impulse is to low analgesic effect is insufficient. It is assumed that the minimum value of TENS which is functional on humans is about 30 mA. If the impulse is too high, it is unpleasant for the patient so clinical standards require a selection of amperage as maximal tolerated [66].

One of the methods that is used to reduce LBP is dry needling. It consists of a musculofascial therapy of trigger points (myofascial trigger points) – painful palpable points of high muscle tension located on superficial and deep muscle fibers and fascia. Such points are characterized by increasing amounts of pain due to compression or stretching and limit the range of motion of the muscle. Dry needles that are usually 150–300 μm wide and 15–50 mm long are put into myofascial trigger points [67]. A reduction in pain is observed, especially after combining this with other therapies. However, pain reduction is observed only for a short duration of time [68]. The assumption that dry needling is more efficient than placebo has no confirmation in clinical trials [69, 70].

Another way to deal with LBP, widely used in sport, is Kinesiology Taping. This method relies on using tapes of different tension that are glued to the skin in order to stabilize joints, stimulate muscle activity and skin mechanoreceptors, reduce muscle tension and feel pain [71]. Kinesiology Taping should create spots of reduced tension in subcutaneous mechanoreceptors and change mechanisms of motor unit activation. After applying tape to the lumbar part of the back extensor, it was observed that the therapeutic effect lasted for no longer than 12 weeks [72]. Kinesiology tapes are supposed to, in theory, deal with every joint dysfunction so clinical trials were performed. Unfortunately, the effect on LBP was insufficient and close to placebo. As such, they should not be used to deal with chronic LBP [73].

MOTOR CONTROL EXERCISES IN LOWER BACK PAIN

Patients with LBP have a tendency to feel fear against any kind of physical activity – this is known as kinesiophobia. They convince themselves that movement triggers pain, so the pain reduction strategy implemented is to abandon any kind of physical activity. This results in muscle weakness, lower endurance and loss of vertebral stability. There was a study to find out if kinesiophobia has some connection to LBP, but data has shown no statistically significant differences. However, as age increases a tendency to avoid movement is noticed, the range of movements in joints are reduced, the fear of having a fall increases and symptoms intensify. It was observed that people with a BMI over 30 feel more discomfort when moving and see a 10–21% increase in pain compared to people with a BMI between 25–30. This is presumed to be connected with higher axial compression on the structures that cause pain because of an increased body mass [74]. Movement avoidance, especially in overweight people, may cause worsening symptoms and create behavior where patients become vulnerable to new diseases and limitations [75]. It was observed that patients with LBP in isometric contraction (with the same length of the muscle) have weaker muscles by 50% – this especially applies to the transversus abdominis, internal oblique and multifidi muscles. This results in lower stability and a weakened endurance of the lumbar part of the spine [76]. If pain intensifies during movement, the compensation strategy takes effect – one movement pattern is replaced by another incorrect but less painful pattern that activates another muscle group [77].

A different therapeutic approach to enhance postural stability and reduce pain is cognitive-behavioral therapy. It assumes that health problems are not only physical, but also emotional and social in nature. Because of uncorrected bad postural habits that are maintained, some movements are subconsciously avoided – so the correction of posture and movement habits is necessary. During meta-analysis, the effectiveness of different psychological methods were tested to deal with LBP. For methods such as relaxation techniques, mindfulness-based techniques (concentrating on internal and external stimuli), cognitive-behavioral therapy, psychoeducation and biofeedback results vary significantly depending on the type and intensity of pain. The effectiveness of these therapies can be determined as low to moderate. However, in the case of LBP the effects are more satisfactory than when treating fibromyalgia, rheumatoid arthritis or myalgia. It is worth mentioning that psychological therapies, especially cognitive-behavioral therapy, cause fatigue to patients [78], but after about 100 h of therapy sessions, the results are promising [79]. However, cognitive-behavioral therapy may be controversial in treating LBP, it shall be applied to therapists

themself – that way, the multifactorial character of chronic pain can be better understood. This holistic way of thinking is in opposition to the structural point of view [80].

Graded activity exercises try to reduce pain and dysfunction through re-educating patients about bad motor habits, physical overburden and movement limitations [81]. The human body undergoes aging processes such as muscle weakness and the loss of proprioception and reflex. Consequently, due to these physiological processes, body balance worsens and falls are more frequent. To delay this process, different exercises are applied – strength workouts, stretching and walking [82]. The loss of correct movement patterns of the spine is considered to be a cause of pain and neurological dysfunction. The spine get its stability from the vertebral column, muscles and motor control unit. It is observed that in LBP, the human body has a tendency to swing in result muscle control and spine stability decreases [83]. Motor control exercises were developed on the assumption that patients with LBP have insufficient deep muscle control and should focus on strengthening the muscular corset to gain strength, muscle coordination and proprioception. The main muscles strengthened during motor control exercises are the internal obliques, external obliques, transversus abdominis, multifidi muscles in the lumbar part of the spine and pelvic floor. Without proper strength in these muscles, it is impossible to remain in one position. This results in no stability of the lumbar spine and a disturbance of motor control [84]. Motor control exercises should improve the stability of the spine during movements and reduce the chance of irritation cause of pain by reducing shock by strengthening muscular corset. These exercises are most frequently recommended for patients to perform by themselves and are a good foundation of self-help in LBP. The effectiveness of motor control exercises is dependent on the severity and cause of pain [1], control over muscles, correct posture and movement patterns which eventually reduce pain and dysfunction [85]. These exercises also enhance muscle durability, range of motion, and balance [86] but when done with too much burden can result in injury [87]. There is not much difference between motor control exercises and graded activity exercises for patients with LBP [88]. No significant difference in results was observed between motor control exercises and other types of physical activity, however, there was a significant difference when compared to people who did not exercise at all [89]. Study shows that stability control exercises, in the longer term, were no more effective than any other kind of physical activity [90]. This results among the facts that even fit people show signs of postural muscles instability, lack of balance and deep muscle activity during stability control exercises. Patients with LBP have a tendency to overactive superficial back muscles that cannot be offset by deep muscle activation [91]. Deep lumbar muscles activate with a delay of 50 ms during an active movement but this time extends by about 8–10 ms if external force is added to an unaware patient. This effect results in a longer period of instability in the lumbar spine increasing the risk of injury [92]. The essence of achieving motor stability is to learn deep muscle control during exercises. The most commonly used motor control exercises are presented below [93, 94, 95].

"The pike"

The starting position in this exercise requires both hands on the ground with the arms and body straightened. Hands are placed on a towel or a mat and toes are on the floor – this can also be done conversely. The exercising person tries to take the form of an upside down letter "V" without flexing the knee or elbow joints, then he or she tries to return to starting position. Primary muscles that are involved in this exercise are the rectus abdominis, transversus abdominis and multifidi (Fig. 3).

FIGURE 3. Starting and final position of "The pike" exercise

"The jackknife"

The starting position in this exercise is to lay back with arms close to the body. The lower spine should stay on the ground for the entirety of the exercise. The rectus abdominis is tense, the head is elevated so as to see the whole body, and the legs are straight and slightly raised with feet in plantar flexion. This position is kept during the whole exercise. The exercising person tries to symmetrically flex the knee and hip joints and then returns to the starting position. The primary muscles involved in this exercise are the rectus abdominis, external and internal oblique abdominis (Fig. 4).

FIGURE 4. Starting and final position of "The jackknife" exercise

FIGURE 5. Starting and final position of the "Heel side bending" exercise

"Heel side bending"

The starting position in this exercise is to lay back with arms close to the body. Knee joints are in flexion, the head is elevated, and the abdomen is tense. The lower spine should not be lifted throughout the exercise. While keeping this position, the exercising person tries to touch their heel and then return to the starting position. Both heels should be touched in turn. All abdominal muscles are involved in this exercise (Fig. 5).

"The bridge"

The starting position in this exercise is to lay back with arms close to the body. Feet are on the floor and the legs flexed at the knee joints. The pelvis is then elevated to create a straight line between the knees and the head. In this exercise, the dorsal extensor, multifidi and transversus abdominis muscles are involved (Fig. 6).

"The plank"

In this exercise, the practitioner remains in a position similar to a push-up for the maximum possible time. The primary muscles involved in this exercise are the erector spinae, rectus abdominis and transversus abdominis (Fig. 7).

FIGURE 6. Starting and final position of "The bridge" exercise

FIGURE 7. "The plank" exercise

"The mountain climbing"

In this exercise, the practitioner has both hands on the ground. The lead leg is flexed at the hip and knee, the trail leg is straightened. During the exercise, the legs swap positions. The primary muscles involved in this exercise are the rectus abdominis, multifidi and erector spinae (Fig. 8).

FIGURE 8. Starting and final position of "The mountain climbing" exercise

"Pancake" exercise

The starting position in this exercise is to lay back with the knee and hip joints flexed, the head is elevated and the abdomen is tense. The practitioner rolls their body forward to sit with legs in a "V" shape with their hands touching the floor. In this exercise it is important to feel the stretch in the hamstring muscles (Fig. 9).

FIGURE 9. Starting and final position of the "Pancake" exercise

SUMMARY

In summary, it must be concluded that the most frequent cause of LBP is a long-lasting repeated overload of the anatomical structures of the spine that adversely affects the quality of life. As was shown, LBP is a problem that appears mainly in late adulthood. There are various factors for the long-term physical and cognitive functioning after multidisciplinary pain rehabilitation. The causes of pain are often connected to prevalent diseases and health deficits induced by infections, psychosomatic changes and chronic diseases where disc degeneration is a common element. Different ways of dealing with pain that have an interaction with morpho-functional parameters were presented. Motor control exercises have provided significant results in LBP rehabilitation in addition to other therapeutic methods. In conclusion, it is worth mentioning, by referring to de Walden-Gałuszko and Majkowicz, that pain is not only a real and potential tissue damage. Often, psychological aspects of pain in clinical trials were seen as an emotional reaction to the physical pain sensation demonstrating a better or worse adaptation to a new situation. Essential to restore lost health resources in medical and rehab activities become inclusion of BPS model of pain, in which pain perception consists both in the pain sensation, and knowledge and reflections on the new condition. Pain behaviors are an effect of the beliefs and reaction of the patient, effects of medical and rehab activities, social background, especially when help in dealing with pain was received [96]. Chronic pain is connected to the quality

of life and should not be only considered on a diagnostic and therapeutic level, especially when mechanisms of the etiopathogenesis of LBP corelate with fear, depression, sleep disorders, chronic exhaustion and social dysfunctions [97]. There is good evidence for the role of biological, psychological and social factors in the etiology and prognosis of back pain [98]. However, the majority of well-known studies about the BPS model in LBP management focus on the biological aspects while the psychological and social components receive less attention [99]. With an insufficient number of studies in the psycho-social factors of LBP, there is space for further investigation. New studies suggests that there is a connection between lifestyle stress, stigma, discrimination and interpersonal aspects of LBP management. This approach adds a new component to desirable patient centered care. A comprehensive recognition of this problem may prevent the perception of people as only vital resources through the prism of extreme reductionism, dehumanizing modern medicine and the domain of health sciences.

REFERENCES

1. Rajabi R, Ahmadi Barati A, Farhadi L. Effect of Core Stability Exercises at Home on Functional Ability and Chronic Low Back Pain (LBP) in Male Dentists. J Clin Res Paramed Sci 2018;7(2):1-4.
2. Philadelphia Panel. Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for low back pain. Phys Ther 2001;81(10):1641-74.
3. Krekoukias G, Gelalis ID, Xenakis T, Gioftsos G, Dimitriadis Z, Sakellari V. Spinal mobilization vs conentional physiotherapy in the management of chronic low back pain due to spinal disk degeneration: a randomized controlled trial. J Man Manip Ther 2017;25(2):66-73.
4. Hulens M, Vangant G, Claessens AL, Lysens R, Muls E. Predictors of 6-minute walk test results in lean, obese and morbidly obese women. Scand J Med Sci Sports 2003;13(2):98-105.
5. Wojtyna E. O bólu i radzeniu sobie z nim w kontekście współczesnej mentalności. In: Górnik-Durose M, editor. Kultura współczesna a zdrowie. Sopot: Gdańskie Wydawnictwo Psychologiczne; 2013. p. 135-53.
6. LeResche L. Gender considerations in the epidemiology of chronic pain. In: Epidemiology of Pain. Seattle: IASP Press; 1999. p. 45-7.
7. Jeffries LJ, Milanese SF, Grimmer-Somers KA. Epidemiology of adolescent spinal pain: a systematic overview of the research literature. Spine (Phila Pa 1976) 2007;32(23):2630-7.
8. Dionne CE, Dunn KM, Croft PR. Does back pain prevalence really decrease with increasing age? A systematic review. Age Ageing 2006;35(3):229-34.
9. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, et al. A systematic review of the global prevalence of low back pain. Arthritis Rheum 2012;64(6):2028-37.
10. Solomou A, Kraniotis P, Rigopoulou A, Petsas T. Frequent benign, nontraumatic, noninflammatory causes of low back pain in adolescents: MRI findings. Radiol Res Pract 2018;2018: 7638505.
11. Sheeran L, Coales P, Sparkes V. Clinical challenges of classification based targeted therapies for non-specific low back pain: what do physiotherapy practitioners and managers think? Man Ther 2015;20(3):456-62.
12. Herndon CM, Zoberi KS, Gardner BJ. Common questions about chronic low back pain. Am Fam Physican 2015;91(10):708-14.
13. van Tulder M, Becker A, Bekkering T, Breen A, del Real MT, Hutchinson A, et al. Chapter 3. European guildelines for the management of acute nonspecific low back pain in primary care. Eur Spine J 2006; 15 Suppl 2(Suppl 2):S169-91.
14. Airaksinen O, Brox JI, Cedraschi C, Hildebrandt J, Klaber-Moffett J, Kovacs F, et al. Chapter 4. European guidelines for the management of chronic nonspecific low back pain. Eur Spine J 2006; 15 Suppl 2(Suppl 2):S192-300.
15. Urban JPG, Roberts S. Degeneration of the intervertebral disc. Arthritis Res Ther 2003;5(3):120-30.
16. Yu J, Winlove PC, Roberts S, Urban JPG. Elastic fibre organization in the intervertebral discs of the bovine tail. J Anat 2002;201(6):465-75.
17. Shapiro IM, Risbud MV, editors. The intervertebral disc: molecular and structural studies of the disc in health and disease. Wien: Springer-Verlag; 2014. p. 177-99.
18. Taher F, Essig D, Lebl DR, Hughes AP, Sama AA, Cammisa FP, et al. Lumbar degenerative disc disease: current and future concepts of diagnosis and management. Adv Orthop 2012;2012:970752.
19. Katz JN. Lumbar disc disorders and low-back pain: socioeconomic factors and consequences. J Bone Joint Surg Am 2006; 88 Suppl 2:21-4.
20. Vibe Fersum K, O'Sulivan P, Skouen JS, Smith A, Kvåle A. Efficacy of classification-based cognitive functional therapy in patients with non-specific chronic low back pain: A randomized controlled trial. Eur J Pain 2013;17(6):916-28.
21. Thorbjornsson CO, Affredsson L, Fredriksson K, Koster M, Michelsen H, Vingard E, et al. Psychological and physical risk factors associated with low back pain: a 24 year follow up among women and men in a broad range of occupations. Occup Environ Med 1998;55(2):84-90.
22. Hansson TH, Keller TS, Spengler DM. Mechanical behavior of the human lumbar spine. II. Fatigue strength during dynamic compressive loading. J Orthop Res 1987;5(4):479-87.
23. Abou-Elroos DA, El-Toukhy MAE, Nageeb GS, Dawood EA, Abouhashem S. Prolongated physiotherapy versus early surgical intervention in patients with lumbar disc hermitatnion: short-term outcomes of clinical randomized trial. Asian Spine J 2017;11(4):531-7.
24. Rim DC. Quantitative pfirrmann disc degeneration grading system to overcome the limitation of pfirrmann disc degeneration grade. Korean J Spine 2016;13(1):1-8.
25. Hancock MJ, Maher CG, Latimer J, Spindler MF, McAuley JH, Laslett M, et al. Systematic review of tests to identify the disc, SIJ or facet joint as the source of low back pain. Eur Spine J 2007;16(10):1539-50.
26. Teraguchi M, Samartzis D, Hashizume H, Yamada H, Muraki S, Oka H, et al. Classification of high intensity zones of the lumbar spine and their associaation with other spinal mri phenotypes: the wakayama spine study. PLoS One 2016;11(9):e0160111.
27. Moore RJ. The vertebral endplate: disc degeneration, disc regeneration. Eur Spine J 2006;15(Suppl 3):333-7.
28. Pagé GM, Lacasse A, Quebec Back Pain Consortium. The Quebec Low Back Pain Study: a protocol for an innovative 2-tier provincial cohort. Pain Rep 2019;5(1);e799.
29. Hadjistavropoulos HD, Craig KD. Acute and chronic low back pain: cognitive, affective, and behavioral dimensions. J Consult Clin Psychol 1994;62(2):341-9.
30. De Walden-Gałuszko K. Psychologiczne aspekty bólu i jego leczenia. Med Palat Prakt 2007;1(2):66-70.
31. Butler DS, Moseley GL. Explain pain. Adelaide: Noigroup Publications; 2003. p. 94-100.
32. Asmundson G, Gomez-Perez L, Richter AA, Cerleton RN. The psychology of pain: models targets comprehensive assessment. In: van Griensven H, Strong J, Unruh AM, editors. Pain: a textbook for health professionals. Amsterdam: Elsevier; 2012. p. 35-43.
33. Linton SJ, Boersma K, Jansson M, Overmeer T, Lindblom K, Vlaeyen JW. A randomized controlled trial of exposure *in vivo* for patients with spinal pain reporting fear of work-related acrivities. Eur J Pain 2008;12(6):722-30.
34. Karos K, Williams AC, Meulders A, Vlaeyen JW. Pain as a threat to the social self: a motivational account. Pain 2018;159(9):1690-5.
35. Mescouto K, Olson RE, Hodges PW, Setchell J. A critical review of the biopsychosocial model of low back pain care: time for new approach? Disabil Rehabil 2020:1-15.
36. Gatchel RJ, Peng YB, Peters ML, Fuchs PN, Turk DC. The biopsychosocial approach to chronic pain: scientific advances and future directions. Psychol Bull 2007;133(4):581-624.
37. Klyne DM, Moseley GL, Sterling M, Barbe MF, Hodges PW. Are signs of central sensitization in acute low back pain a precursor to poor outcome? J Pain 2019;20(8):994-1009.
38. Cowell I, O'Sullivan P, O'Sullivan K, Poyton R, McGregor A, Murtagh G. Perceptions of physiotherapists towards the management of non-specific chronic low back pain from a biopsychosocial perspective: a qualitative study. Musculoskeletal Sci Pract 2018;38:113-9.

39. Flink IK, Reme S, Jacobsen HB, Glombiewski J, Vlaeyen JWS, Nicholas MK, et al. Pain psychology in the 21st century: lessons learned and moving forward. Scand J Pain 2020;20(2):229-38.
40. Leerar P, Boissonnault W, Domholdt E, Roddey T. Documentation of red flags by physical therapists for patients with low back pain. J Man Manip Ther 2007;15(1):42-9.
41. Flink IK, Smeets E, Bergboma S, Peters ML. Happy despite pain: pilot study of a positive psychology intervention for patients with chronic pain. Scand J Pain 2015;7(1):71-9.
42. Richle KA, Romano JM, Jensen MP. Partner responses to patient pain and well behaviors and their relationship to patient pain behavior, functioning, and depression. Pain 2011;152(1):82-8.
43. Zangoni G, Thomson OP. 'I need to do another course' – Italian physiotherapists' knowledge and beliefs when assessing psychosocial factors in patients presenting with chronic low back pain. Musculoskelet Sci Pract 2017;27:71-7.
44. Innes E, Crowther A, Fonti F, Quayle L. Women's health at work program: Musculoskeletal pain experience by women of Chinese background working on market gardens in the Sydney basin. Work 2010;36(2):129-40.
45. Abad V, Boyce E. Issues in psychiatric evaluations of Puerto-Ricans. A sociocultural perspective. J Operational Psychiatry 1979;10(1):28-39.
46. Sex and Gender Issues in Pain. In: Charlton JE, editor. Core curriculum for professional education in pain. Seatle: IASP Press; 2005. p. 1-5.
47. Kerns RD, Rosenberg R, Jacob MC. Anger expression and chronic pain. J Behav Med 1994;17(1):57-67.
48. Cano A, Mayo A, Ventimiglia M. Coping, pain severity, interference, and disability: the potential mediating and moderating roles of race and education. J Pain 2006;7(7):459-68.
49. Bakker EWP, Verhagen AP, Lucas C, Koning HJ, Koes BW. Spinal mechanical load: a predictor of persistent low back pain? A prospective cohort study. Eur Spine J 2007;16(7):933-41.
50. Roland M, Fairbank J. The Roland–Morris disability questionnaire and the oswestry disability questionnaire. Spine (Phila Pa 1976) 2000;25(24):3115-24.
51. Sullivan MJL, Bishop S, Pivik J. The pain catastrophizing scale: development and validation. Psychology Assessment 1995;7(4):524-32.
52. Fairback JC, Pynsent PB. The Oswestry disability index. Spine (Phila Pa 1976) 2001;25(22):2940-52.
53. Jaeschke R, Singer J, Guyatt GH. Measurement of health status: ascertaining the minimal clinically important difference. Control Clin Trials 1989;10(4):407-15.
54. Deyo RA, Rainville J, Kent DL. What can the history and physical examination tell us about low back pain? JAMA 1992;268(6):760-5.
55. Acute low back problems in adults: assessment and treatment. Agency for Health Care Policy and Research. Clin Pract Guidel Quick Ref Guide Clin 1994;(14):iii-iv, 1-25.
56. Kraus JF, Schaffer KB, McArthur DL, Peek-Asa C. Epidemiology of acute low back injury in employees of a large home improvement retail company. Am J Epidemiol 1997;146(8):637-45.
57. Oliphant D. Safety of Spinal Manipulation in the Treatment of Lumbar Disk Herniations. J Manipulative Physiol Ther 2004;27(3):197-210.
58. Schwind J, Learman K, O'Halloran B, Showalter C, Cook C. Different minimally important clinical difference (MCID) scores lead to different clinical prediction rules for the Oswestry disability index for the same sample of patients. J Man Manip Ther 2013;21(2):71-8.
59. Andicochea CT, Fulkerson J, Taylor BM, Portouw SJ. Manual Therapy for Chronic Low Back Pain in an f-5 Pilot. Mil Med 2015;180(10):e1132-5.
60. Licciardone JC, Minotti DE, Gatchel RJ, Kearns CM, Singh KP. Osteopathic manual treatment and ultrasound therapy for chronic low back pain: a randomized controlled trial. Ann Fam Med 2013;11(2):122-9.
61. Draper DO. Facts and misfits in ultrasound therapy: steps to improve your treatment outcomes. Eur J Phys Rehabil Med 2014;50(2):209-16.
62. Rantonen J, Karppinen J, Vehtari A, Luoto S, Viikari-Juntura E, Hupli M, et al. Effectiveness of three interventions for secondary prevention of low back pain in the occupational health setting – a randomised controlled trial with a natural course control. BMC Public Health 2018;18(1):598.
63. Patrick N, Emanski E, Knaub MA. Acute and chronic low back pain. Med Clin North Am 2014;98(4):777-89.
64. Buchmuller A, Navez M, Milletre-Bernardin M, Pouplin S, Presles E, Lantéri-Minet M, et al. Value of TENS for relief of chronic low back pain with or without radicular pain. Eur J Pain 2012;16(5):656-65.
65. Facci LM, Nowotny JP, Tormem F, Trevisani VF. Effects of transcutaneous electrical nerve stimulation (TENS) and interferential currents (IFC) in patients with nonspecific chronic low back pain: randomized clinical trial. Sao Paulo Med J 2011;129(4):206-16.
66. Vance CGT, Dailey DL, Rakel BA, Sluka KA. Using TENS for pain control: the state of the evidence. Pain Manag 2014;4(3):197-209.
67. Kalichman L, Vulfsons S. Dry needling in the management of musculoskeletal pain. J Am Board Fam Med 2010;23(5):640-6.
68. Furlan AD, van Tulder M, Cherkin D, Tsukayama H, Lao L, Koes B, et al. Acupuncture and dry-needling for low back pain: an updated systematic review within the framework of the cochrane collaboration. Spine (Phila Pa 1976) 2005;30(8):944-63.
69. Cummings TM, White AR. Needling therapies in the management of myofascial trigger point pain: a systematic review. Arch Phys Med Rehabil 2001;82(7):986-92.
70. Koppenhaver SL, Walker MJ, Smith RW, Booker JM, Walkup ID, Su J, et al. Baseline examination factors associated with clinical improvement after dry needling in individuals with low back pain. J Orthop Sports Phys Ther 2015;45(8):604-12.
71. Kase K, Tatsuyuki H, Tomoki O. Development of Kinesio™ Tape Kinesio™ Taping perfect manual. Kinesio Taping Association 1996;6-10:117-8.
72. Parreira Pdo C, Costa Lda C, Takahashi R, Hespanhol Junior LC, Luz Junior MA, Silva TM, et al . Kinesio taping to generate skin convolutions is not better then sham taping for people with chronic non-specific low back pain: a randomised trial. J Physiother 2014;60(2):90-6.
73. Luz Júnior MA, Sousa MV, Neves LA, Cezar AA, Costa LO. Kinesio Taping® is not better then placebo in reducing pain and disability in patients with chronic non-specific low back pain: a randomized controlled trial. Braz J Phys Ther 2015;19(6):482-90.
74. Vincent HK, Seay AN, Montero C, Conrad BP, Hurley RW, Vincent KR. Kinesiophobia and fear-avoidance beliefs in overweight older adults with chronic low-back pain: relationship to walking endurance – part II. Am J Phys Med Rehabil 2013;92(5):439-45.
75. Vincent HK, Omli MR, Day TI, Hodges M, Vincent KR, George SZ. Fear of movement, quality of life, and self-reported disability in obese patients with chronic lumbar pain. Pain Med 2011;12(1):154-64.
76. Rostami M, Ansari M, Noormohammadpour P, Mansournia MA, Kordi R. Ultrasound assessment of trunk muscles and back flexibility, strength and endurance in off-road cyclists with and without low back pain. J Back Musculoskeletal Rehabil 2015;28(4):635-44.
77. van der Hulst M, Vollenbroek-Hutten MM, Rietman JS, Schaake L, Groothuis-Oudshoorn KG, Hermens HJ. Back muscle activation patterns in chronic low back pain during walking: a "guarding" hypothesis. Clin J Pain 2010;26(1):30-7.
78. Hofmann SG, Asnaani A, Vonk IJ, Sawyer AT, Fang A. The efficacy of cognitive behavioral therapy: a review of meta-analyses. Cognit Ther Res 2012;36(5):427-40.
79. Smeets RJ, Vlaeyen JW, Hidding A, Kester AD, van der Heijden GJ, van Geel AC, et al. Active rehabilitation for chronic low back pain: Cognitive-behavioral, physical, or both? First direct post-treatment results from a randomized controlled trial. BMC Musculoskeletal Disord 2006;7:5.
80. Synnott A, O'Keeffe M, Bunzli S, Dankaerts W, O'Sullivan P, Robinson K, et al. Physiotherapists report improved understanding of and attitude toward the cognitive, psychological and social dimensions of chronic low back pain after Cognitive Functional Therapy training: a qualitative study. J Physiother 2016;62(4):215-21.
81. Leeuw M, Goossens MEJB, Linton SJ, Crombez G, Boersma K, Vlaeyen JWS. The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. J Behav Med 2007;30(1):77-94.
82. Kang KY. Effects of core muscle stability training on the weight distribution and stability of the elderly. J Phys Ther Sci 2015;27(10):3163-5.
83. Panjabi MM. Clinical spinal instability and low back pain. J Electromyogr Kinesiol 2003;13(4):371-9.
84. Chang WD, Lin HY, Lai PT. Core strength training for patients with chronic low back pain. J Phys Ther Sci 2015;27(3):619-22.
85. Moseley GL, Hodges PW, Gandevia SC. Deep and superficial fibers of the lumbar multifidus muscle are differentially active during voluntary arm movements. Spine (Phila Pa 1976) 2002;27(2):E29-36.
86. Nadler SF, Malanga GA, Bartioli LA, Feinberg JH, Prybicien M, Deprince M. Hip muscle imbalance and low back pain in athletes: influence of core strengthening. Med Sci Sports Exerc 2002;34(1):9-16.

87. Hibbs AE, Thompson KG, French D, Wrigley A, Spears I. Optimizing performance by improving core stability and core strength. Sports Med 2008;38(12):995-1008.
88. Macedo LG, Litimer J, Maher CG, Hodges PW, McAuley JH, Nicholas MK, et al. Effect of motor control exercises versus graded activity in patients with chronic nonspecific low back pain: a randomized control trial. Phys Ther 2012;92(3):363-77.
89. Saragiotto BT, Maher CG, Yamato TP, Costa LOP, Menezes Costa LC, Ostelo RW, et al. Motor control exercise for chronic non-specific low-back pain. Cochrane Database Syst Rev 2016;8(1): CD012004.
90. Smith BE, Littlewood C, May S. An update of stabilisation exercises for low back pain: a systematic review with meta-analysis. BMC Musculoskelet Disord 2014;15:416.
91. Akuthota V, Ferreiro A, Moore T, Fredericson M. Core stability exercise principles. Curr Sports Med Rep 2008;7(1):39-44.
92. Moseley GL, Hodges PW, Gandevia SC. External perturbation of the trunk in standing humans differentially activates components of the medial back muscles. J Physiol 2003;547(Pt 2):581-7.
93. Bryant J. Train Smarter with the 7 best core strengthening exercises. https://www.bodyset.co.uk/fitness/train-smarter-with-the-7-best-core-strengthening-exercises/ (28.04.2017).
94. Barbado D, Iries-Vidal B, Prat-Luri A, Garcia-Vaquero MP. Training intensity quantification of core stability exercises based on a smartphone accelerometer. PloS One 2018;13(12):e0208262.
95. Joseph LH, Hancharoenkul B, Sitilertpisan P, Pirunsan U, Paungmali A. Comparison of effects between core stability training and sports massage therapy among elite weightlifters with chronic non-specific low back pain: a randomized cross-over study. Asian J Sports Med 2018;9(1): e58644.
96. De Walden-Gałuszko K, Majkowicz M. Psychologiczno-kliniczna ocena bólu przewlekłego. Wskazania dla lekarzy pierwszego kontaktu oraz poradni przeciwbólowych i paliatywnych. Gdańsk: Akademia Medyczna; 2003.
97. Chojnacka-Szawłowska G. Jakość przekonań o doświadczanym bólu a funkcjonowanie emocjonalne i zachowanie chorych. In: Leppert W, Majkowicz M, editors. Ból przewlekły. Ujęcie kliniczne i psychologiczne. Warszawa: PZWL Wydawnictwo Lekarskie; 2018. p. 81-99.
98. Pincus T, Kent P, Bronfort G, Loisel P, Pransky G, Hartvigsen J. Twenty-five years with the biopsychosocial model of low back pain – is it time to celebrate? A report from the twelfth international forum for primary care research on low back pain. Spine (Phila Pa 1976) 2013;38(24):2118-23.
99. Bath B, Lovo Grona S. Biopsychosocial predictors of short-term success among people with low back pain referred to a physiotherapy spinal triage service. J Pain Res 2015;8:189-202.