Benefits of aquatic exercise therapy on locomotion in low back pain subjects: a narrative literature review

Karen Przybysz da Silva Rosa, Flávia Gomes Martinez, and Leonardo Alexandre Peyré-Tartaruga*

Exercise Research Laboratory, School of Physical Education, Physical Therapy and Dance, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

Received 27 July 2016, Accepted 6 February 2017

Abstract—The purpose of this narrative literature review was to analyze the effects of aquatic exercise therapy on low back pain, specifically focusing on gait disorders. Approximately 80% of the population will experience an episode of low back pain in some point of their lives, particularly with aging. Low back pain have high social and health care cost, both for its prevalence, as for its cost regarding reduced or productivity lost. Etiology of low back pain is not fully comprehended, but some behavioral determinants can lead to its development and persistence. This health disorder leads to pain, disability, and alterations in walking and muscular activation patterns. Possible treatments for individuals with low back pain vary and present different levels of improvement and include medication, physiotherapy, aquatic physiotherapy, a range of manual therapies, and adapted exercises. The primary goal of treatment should be pain relief, strengthening of trunk muscles, trunk mobility, aerobic exercises and behavior education. The aquatic therapy is a promising and interesting non-invasive intervention for the gait disorders of individuals with low back pain, but more consistent and controlled studies are necessary to judge the effectiveness of this treatment.

Keywords: LBP, walking, aquatic exercise, biomechanics, rehabilitation

1 Introduction

The low back pain is a health multifactorial disorder characterized by pain in the lumbar region. The World Health Organization estimated that approximately 80% of the world’s population suffered from low back pain at some point in life (World Health Organization, 2015). Although the exact estimates differ drastically depending on definitions and other methodological aspects, as statistical sampling procedures, inclusion criteria (Andersson, 1999; Garcia, et al., 2014; Jöud, Petersson, & Englund, 2012), the prevalence of low back pain increased very slightly over the past three decades (Hoy, et al., 2012). Health care cost is doubled in patients with low back pain in
comparison to general population (Jöund, et al., 2012), with social cost additional in terms of reduced or lost productivity (Garcia, et al., 2014).

The etiology of low back pain is varied, and in some individuals is unknown. Notwithstanding, there is an agreement that repetitive and prolonged stresses on spine associated with posture and repetitive movements are related to development and persistence of low back pain (Gombatto, et al., 2015). The low back pain can be characterized as an episodic health problem. But when the pain lasts for more than 3 months, it is designated chronic or persistent low back pain (Garcia, et al., 2014), causing disability and leading to obesity, and impairments in strength, extensibility, endurance and function (Baena-Beato, Arroyo-Morales, Delgado-Fernández, Gatto-Caridia, & Artero, 2013).

Specifically on locomotor aspects, self-selected walking speed is reduced in low back pain, from 1.31 m s⁻¹ in healthy controls to 0.92 m s⁻¹ in pain sufferers (Lamoth, et al., 2002). This behavioral attribute altered is accompanied by a reduced range of scapular and pelvic girdle motion during walking (Gombatto, et al., 2015). The gait resulting is characterized biomechanically by a lower stride length, higher lumbar muscle activity during the step, and lower vertical ground reaction forces (Carvalho, Andrade, & Peyré-Tartaruga, 2015). However, those changes do not seem to implicate in differences in walking economy between healthy controls and individuals with chronic low back pain (Carvalho, Bertor, et al., 2015; Henchoz, Soldini, Peyrot, & Malatesta, 2015).

There is a myriad of approaches and methods for treating chronic low back pain (Shnayderman & Katz-Leurer, 2013). Nonsteroidal anti-inflammatory drugs (NSAIDs), muscle relaxants, antidepressants, and opioid are often used in acute and chronic low back pain as medicament treatment, and other adjunctive treatment options include physical therapy, a period of immobilization, ice, ultrasound, massage, and transcutaneous electrical nerve stimulation (Patrick, Emanski, & Knaub, 2016). Aerobic walking programs and strengthening exercises are effective for functional gain (Shnayderman & Katz-Leurer, 2013) and reducing pain (Baena-Beato, et al., 2013) improving strength, endurance, flexibility of soft tissue and aerobic capacity (Baena-Beato, et al., 2013).

The aquatic therapy and water immersion exercises have become popular to mitigate the deleterious on quality of life, health-related fitness parameters and disability of low back pain patients (Baena-Beato, et al., 2013). The physical properties of water immersion as buoyancy and thermal conductivity are primary aspects for sustaining the aquatic therapy as a potential rehabilitation strategy for low back pain. For example, results support the use of aquatic exercise for decreasing the compressive forces on the spine compared with exercise on land (Dowzer, Reilly, Cable, & Nevill, 1999). Conversely, the possible exaggerated spinal rotation during aquatic exercise should be carefully evaluated, especially in individuals that walk with asymmetrical lumbar rotation and flexion (Gombatto, et al., 2015).

Owing to the various etiologies of low back pain, and methodological differences in studies of the implications of low back pain in walking, we sought to discuss some of these gaps in the literature. The primary purpose of the narrative literature review was to analyze the main biomechanical changes on walking pattern in these individuals. The secondary purpose was to discuss the state-of-art and future trends of research evaluating the aquatic and conventional interventions for the rehabilitation of people with low back pain.

2 Methods

The database used to search the words “aquatic exercise”, “water immersion intervention”, “aquatic therapy”, “LBP”, “back pain”, “gait”, and “walking” was the MEDLINE/PubMed during March and April 2016. The screening of articles was based on main purpose of manuscript and we did not restrain the publication date. We found only 2 studies with that directly and entirely (randomized controlled trials) addressed the questions of the review. Therefore, we decided to carry out a narrative literature review, using articles with a lower level of evidence, but still useful to understand the potential impact of aquatic interventions on gait of low-back pain individuals.

We also carried out a manual and electronic search of articles that were not registered in databases and also those obtained through references lists of articles obtained through the databases. In addition to this search terms, we used a list of sensitive terms for the search of RCTs (proposed by Robinson and Dickersin (2002)).

The complete search strategy used in PubMed can be visualized in Table 1.

2.1 Low back pain: etiology, symptoms and diagnosis

The low back pain worldwide prevalence is estimated to be 31.0% (Hoy, et al., 2012), being more common in women, individuals with less schooling, lower economic status, obese and smoker (Meucci, Fassa, & Faria, 2015). Also, differ among aging, with high prevalence during adolescence, declining among 20–29 years, and progressively increasing until 40–69 years, when slowly decreases thereafter (Hoy, et al., 2012). Individuals aged over 50 years suffer three to four times more with low back pain compared to those aged 18–30 years (Meucci, et al., 2015). Risk factors include inadequate work position, obesity, overweight, pregnancy, smoking, domestic work, lifting and carrying heavy loads, sedentary lifestyle (Garcia, et al., 2014), educational status, psychological factors and job satisfaction (Patrick, et al., 2016). Recurrence rates are high, varying from 20% to 85% with men having highest risk of recurrence than women (Andersson, 1999).

There are some key aspects in the evaluation of patients that present back pain such as duration of symptoms, description of pain and its location, presence of neurological symptoms, changes in bowel and bladder function, history of infections, and other osteoarticular
Table 1. Search strategy used in PubMed.

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conditions (Patrick, et al., 2016). There are also some red flags, with a 10% chance they have a serious underlying source of their low back pain symptoms if more than 2 of these red flags are present: more than 50 years, unintentional weight loss, fever and chills, night sweats, fatigue, history of malignancy, nonmechanical pain, current bacterial infection, immunosuppression, prolonged corticosteroid use, trauma, history of intravenous drug use, and failure of response to initial treatment/therapy (Patrick, et al., 2016). Most patients presenting an episode of acute low back pain will have improvement in their clinical symptoms within a few days to a week (Patrick, et al., 2016).

Diagnostic information in low back pain usually does not completely explain outcomes, and in a minority of cases, a pathoanatomic diagnosis is reached (Kongsted, Kent, Axen, Downie, & Dunn, 2016). Also, imaging exams does not reveal an exact pathological diagnostic in most patients (Patrick, et al., 2016). Low back pain may appear during or after pregnancy (Mogren & Pohjanen, 2005), in consequence of degeneration and reduction of intervertebral disk height, caused in general by intradiscal fluid loss (Simmerman, Sizer, Dedrick, Apte, & Brismée, 2011), or even due to muscle contracture or in consequence of a more severe spinal disease.

Low back pain individuals present less anterior pelvic tilt (~4.1°) and more left rotation than control groups in standing position (Gombatto, et al., 2015). Functional magnetic resonance images have shown reduced brain activation within the supplementary motor area and superior temporal gyrus and sulcus, and enhanced functional connectivity in motor imagery network of daily activities in people with chronic low back pain compared to health individuals. This finding might be associated with maladaptive brain mechanisms (Vrana, et al., 2015).

The definition and classification of acute and chronic low back pain vary among studies, some considering acute when symptoms last less than 4 weeks (Mantel, Peterson, & Humphreys, 2016), and chronic when the pain is uninterrupted for a period equal to or greater than 3 months (Meucci, et al., 2015), or not necessary continuous, ranging from more than 12 weeks (Henchoz, et al., 2015; Lawford, Walters, & Ferrar, 2015), to more than 6 months (Patrick, et al., 2016; van den Hoorn, Bruijn, Meijer, Hodges, & van Dieën, 2012). Even, some authors classify a subacute low back pain period ranging between 6 and 12 weeks duration (Cramer, Lauche, Haller, & Dobos, 2013). Those differences may occur because after first crises, pain decreases rapidly within 1 month and continuous to decreases more slowly until about 3 months (Pengel, Herbert, Maher, & Refshauge, 2003). Pain levels that remain after this period are nearly constant until 12 months follow-up (Pengel, et al., 2003). Mostly low back pain is categorized as non-specific low back pain, and characterization of its course and trajectory may be a better categorization than the duration of symptoms (Kongsted, et al., 2016).

Among medicine therapy, studies has demonstrated small functional improvements from long-term use of opioid, and they are at risk for adverse effects that include central nervous system depression, constipation, and development of tolerance (Patrick, et al., 2016). NSAIDs are the most commonly used, and they are as effective as other medication classes but harbor the potential for gastrointestinal side effects (Patrick, et al., 2016). Other non-pharmacological therapies will be discussed below.

2.2 Walking impairment

Although the low back pain is the most common cause of disability among young adults, about 80–85% of back pain episodes have no known cause (World Health Organization, 2015). The low back pain is strongly associated with obesity, overweight and reduced activities of daily living in Latin America (Garcia, et al., 2014). One critical physical activity is locomotion and, specifically, walking is the most frequent activity of daily living.

Patient with low back pain modifies their gait patterns. The probable mechanism for the gait alterations is related to an attempt to minimize loads on the spine and avoid pain. The self-selected walking speed is reduced in low back pain individuals (1.11–1.17 m s⁻¹) attaining about 60–75% of speeds chosen by counterparts controls (Gombatto, et al., 2015; Henchoz, et al., 2015; Lamoth, et al., 2002; Lamoth, Stins, Pont, Kerckhoff, & Beek, 2008; Müller, Ertelt, & Blickhan, 2015; Selles, Wagenaar, Smit, & Wuisman, 2001; Taylor, Evans, & Goldie, 2003; van den Hoorn, et al., 2012) but extremely dependent on level and presence of acute pain during the exercise. At self-selected speed, the main alterations are the reduced stride length (Lamoth, et al., 2008; Taylor, et al., 2003), the vertical ground reaction force also lowered (Müller, et al., 2015), lumbar and pelvic movements inhibited (Taylor, et al., 2003) and electromyography activation altered, specifically in the trunk and pelvis region (Ghamkhar & Kahlalea, 2015; Lamoth, et al., 2002; Vogt, Pfeifer, Portscher, & Banzer, 2001). Furthermore, at the self-selected speed, the ankle joint is more extended, and the knee joint is more flexed at the foot-ground impact in low back pain than in
healthy subjects (Ertelt, Müller, & Blickhan, 2015). Nevertheless, they present a higher perceived exertion in some speeds (Henchoz, et al., 2015), but there is no differences in stride frequency, stride length (van den Hoorn, et al., 2012) or mediolateral displacement when compared to healthy controls in matched velocities (Henchoz, et al., 2015).

When the low back pain individuals are asked to walk faster, the symptoms above are partly inhibited (Taylor, et al., 2003). That is, acute low back pain compensates the reduction of stride length at the self-selected speed, increasing the stride length in greater proportion than controls or low back pain subjects without pain. These alterations do not occur in chronic low back pain individuals, including maintaining of lumbar and pelvic movements similar to controls (Selles, et al., 2001). On the other hand, when the self-selected speed and stride length are lowered under the influence of an attention demanding task, implying that therapeutic interventions should pay attention to movement coordination as well as cognitive abilities for individuals with low back pain (Lamoth, et al., 2008).

Indeed, the gait control seems to be altered at the self-selected speed, specifically to control the trunk-pelvis movement in low back pain subjects. It has been demonstrated that in control subjects there is a changing from in-phase coupling between upper and lower torso at low walking speeds to an out-of-phase coupling at faster speeds (van Emmerik & Wagenaar, 1996). In low back pain with acute pain, the in-phase pattern remains at faster walking speed. A more ‘rigid’ control of trunk movement indicates another strategy to avoid pain in low back pain (Lamoth, et al., 2002; Selles, et al., 2001).

Therefore, specific interventions would be recommended in order to improve intersegmental coordination during walking (Lamoth, et al., 2002). The gait control modified along the reduced range of scapular and pelvic girdle motion found in low back pain with a low level of pain (Seay, Van Emmerik, & Hamill, 2011) indicating that low back pain subjects incorporate a motor control strategy to produce a “guarded gait”. Moreover, the stride length variability is lower, confirming a less variable pattern of motor control as in upper body movements in low back pain sufferers (Lamoth, et al., 2008).

The range of lumbar spine motion and the angular velocities for the frontal and transverse planes increase with walking speed in control subjects. Notwithstanding, the range of lumbar spine motion in the sagittal plane does not show changes with walking velocity (Feipel, De Mesmaeker, Klein, & Rooze, 2001). Besides the pelvic movement in the sagittal plane remains unaltered, the hip joint range of motion is reduced in low back pain subjects (Müller, et al., 2015).

These kinematical differences are accompanied by alterations in activation patterns of trunk muscles. The muscular activation of erector spinae, multifidus, obliquus externus and rectus abdominis were found to be increased in low back pain subjects in comparison with controls (Ghamkhar & Kahlae, 2015; Lamoth, et al., 2002; Vogt, et al., 2001). The modified muscles activity seems to be a compensatory mechanism to improve the reduced spinal stability in low back pain (Ghamkhar & Kahlae, 2015).

Moreover, the erector spinae and gluteus maximus are activated for longer times in sufferers than healthy controls. In this concept, the musculoskeletal dysfunctions concerning low back pain typically show specific movement patterns of the pelvis, trunk, and hips in conjunction with markedly altered activation timings of the stabilizing muscles such as gluteus maximus and erector spinae (Vogt, et al., 2001). Low back pain patients seem to activate the biceps femoris at the end of swing phase much earlier and more strongly than control subjects (Vogt, et al., 2001) and concomitantly the knee joint acceleration is not reduced immediately before and after touchdown. While the healthy people reduce the knee joint acceleration approximately 50 ms before the contact, the low back pain subjects will apply the strategy after the contact and, for that, it can be assumed that this could lead to a structural overusing and, as a consequence, to painful symptoms (Ertelt, Müller, & Blickhan, 2016). The paradox function of biceps femoris is supported by a reduced swing phase time that implies in a steeper leg angle at contact (Ertelt et al., 2015).

From an integrative point-of-view, some outcomes supporting that aforementioned biomechanical differences could lead to a deteriorated pendulum-like mechanism of walking in low back pain subjects (Carvalho, Andrade, et al., 2015). But, experimental evidence shows that although the mechanical work is different, the inverted pendulum mechanism as well the metabolic cost is unchanged (Carvalho, Bertor, et al., 2015; Henchoz, et al., 2015). Nor greater activation of trunk/pelvis muscles or the kinematic and kinetic changes can increase the metabolic cost in subjects with low back pain. Collectively, it is evident the need for more studies to analyze low back pain individuals in more controlled experiments (pain control and size effects) and better-defined etiology (e.g. lumbar spinal stenosis).

### 2.3 Conventional rehabilitation care

Overall 60–70% of patients with low back pain recover by 6 weeks and 80–90% by 12 weeks, recovery after this period is slow and uncertain, with fewer than half of those individuals disabled for longer than 6 months returning to work (Andersson, 1999). There are many possible approaches and treatment for low back pain. Not only there are different types of exercises and therapies, but also one characteristic that differs among studies is the duration of physical training protocols. For example, walking interventions vary from 4 weeks to 12 months (Lawford, et al., 2015; Salavati, et al., 2016).

There are a variety of physiotherapeutic modalities and devices that are used to manage and treat low back pain. High-intensity laser therapy leads to greater pain and functionality improvement than ultrasound therapy (Fiore et al., 2011). Other therapies as electrotherapy and exercise therapy reduce pain, improve postural control,
balance, and functional abilities in chronic low back pain patients (Salavati, et al., 2016). Mulligan snags and McKenzie exercises are effective in reducing pain and improving function, with McKenzie extension exercise program improving pain and disability more than Mulligan snags, and the last one more enhancing the lumbar range of motion than the first one (Waqqar, Shakil-Ur-Rehman, & Ahmad, 2016). Farther, McKenzie exercises, multifidus exercises and general exercises can reduce the number of patients with recurrent low back pain and the number of recurrences of low back pain (Macedo, Bostick, & Maher, 2013). Strengthening programs increase functional outcomes in people with chronic low back pain (Shnayderman & Katz-Leurer, 2013). Moreover, there is strong evidence for short-term and moderate evidence for long-term reduction of low back pain and back-specific disability after yoga interventions in comparison to control groups, and in short-term when compared to education groups, but not comparing to usual care or exercises (Cramer, et al., 2013).

Spinal height can be affected by many factors through life, like mechanical stresses and physiological changes, but also height loss can be caused by intervertebral disk degeneration, with reduction of intervertebral disk height, and leading to back pain (Simmerman, et al., 2011). One technique used to improve height loss is the traction. Land base traction can be executed with different techniques such as motorized lumbar traction, gravitational traction devices, and supine traction, that has shown to improve spinal height (Simmerman, et al., 2011).

Walking as therapy for chronic low back pain has shown to improve disability status, quality of life (Lawford, et al., 2015), and functional outcomes (Shnayderman & Katz-Leurer, 2013), being as successful as other non-pharmacological management methods (usual care, exercises classes or specific strength exercises). Compared to other therapies, walking is less effective than conventional therapy or progressively graded exercise therapy in improving the quality of life and reducing disability (Lawford, et al., 2015). Leisure physical activities and sporting activities as recreational swimming, walking, cycling and tai chi can be useful in low back pain patients, however, controlling the intensity and volume of the physical activity is critical (Ribaud, et al., 2013).

Massage therapies, defined as soft-tissue manipulation using hands or mechanical device, shown better results decreasing pain in short but not long term in acute low back pain. Also, the pain and functionality were reduced in acute, sub-acute and chronic low back pain when compared to inactive controls (Farber & Wieland, 2016). When compared to active groups, massage therapies are better for pain reduction in short and long-term, but no differences were found for functionality (Farber & Wieland, 2016).

The above findings, added to beneficial outcomes of exercises for short and long-term in low back pain patients support the idea that a well-structured rehabilitation program should include both approaches, thus rapidly reducing pain levels and improving function, not only in the current crisis but lasting and preventing recurrences. Additionally, people that perform the same activity during extended periods of time and older workers are strongly affected by low back pain. Hence, interdisciplinary work groups should design programs specifically targeting this particular population (Garcia, et al., 2014).

2.4 Aquatic interventions

Aquatic therapy and exercises are of particular interest in low back pain considering its positive effects on the management of signs and symptoms of this condition, markedly the reduced stress in joints, decreased axial loading of the spine, and possibility to perform movements that are usually difficult on land. Furthermore, the continuous limb movement against water resistance results in muscle strength and cardiovascular benefits (Baena-Beato, Delgado-Fernández, et al., 2014). Part of the advantages observed in those patients can be explained by physical properties of water such as thermodynamics, hydrostatic pressure, buoyancy, viscosity, and density.

The body’s density is slightly less than the water, so a body immersed in the water is subject to an upward force (of buoyancy) equal in magnitude to the weight of the fluid it displaces (Becker, 2009). It means that, the more immersed the body, the greater reduction on his/her hydrostatic weight. A person immersed to the symphysis pubis has a reduction of 40% of the body hydrostatic weight, 50% to the umbilicus, and 80% at xiphoid immersion (Becker, 2009). One example of the therapeutic use of buoyancy is the aquatic vertical traction, that is effective at increasing spinal height, and shows a higher reduction in pain when compared to supine land-based traction (Simmerman, et al., 2011).

Also influenced by the level of immersion are cardiorespiratory responses observed during immersion. Due to hydrostatic pressure, the water exerts a compression force in the body that increase by 0.74 mmHg for every 1 cm depth of immersion (Wilcock, Cronin, & Hing, 2006). Consequently causing the fluids to displace upward through the venous and lymphatic systems to the central cavity, increasing the central blood volume and stroke volume, and decrease heart rate (Becker, 2009; Wilcock, et al., 2006). Immersion at hip level shows a significant reduction of heart rate, and these reduction increase as the immersion reaches the umbilicus level, with apparently no interference of sex or age (Kruel, et al., 2014). Exercises performed in water had shown to improve functional aerobic capacity in low back pain patients (Shnayderman & Katz-Leurer, 2013), improve glucose and insulin responses in overweight woman with impaired glucose tolerance (Jones, Meredith-Jones, & Legge, 2009), and increase cerebral blood flow velocity in healthy subjects (Pugh, et al., 2015). These findings are critical for individuals with low back pain. In fact, a recent study demonstrated an association of chronic low back pain with an increased prevalence of lifetime myocardial infarction and other coronary diseases (Fernandez, et al., 2016).
Again, the low back pain leads to obesity (Baena-Beato, et al., 2013) and, it follows that the obesity is a risk factor for low back pain (Garcia, et al., 2014), thus creating a vicious cycle. The reason for the cardiac diseases and obesity may lay in the reduction of physical activities caused by pain and impairment in those subjects. The increase in blood flow is a powerful stimulus for improvement in endothelial function and artery remodeling in humans (Pugh, et al., 2015) what may explain the benefits of water exercises.

Another characteristic of water that influence physiological responses is the thermodynamics of water, once water’s heat capacity is 1000 times greater than an equivalent volume of air, and transferring heat in water is 25 times faster than air (Becker, 2009). At temperatures of 33 °C and 35 °C there is a bradycardia effect, and at 37 °C and 39 °C the heart rate increase, still the stroke volume is increased by approximately 50% at 33 °C and 35 °C, 67% at 37 °C and by 64% at 39 °C and peripheral resistance progressively reduce at increasing temperatures of water immersion (Weston, O’Hare, Evans, & Corrall, 1987). Warm and agitated water can lead to a pain modulation, since pain threshold increases with temperature and turbulence, probably for both sensory overflow and thermoreceptors stimulation (Becker, 2009). Additionally, benefits of thermotherapy include increased muscle elasticity, joint extensibility, analgesia and reduction of muscle spasm (Wilcock, et al., 2006). Based on an integrative approach, all these findings indicate and support the notion of at similar intensity, the water immersion exercises generate lower ratings of perceived exertion in comparison to land exercises (Lim & Rhi, 2014; Pinto, et al., 2015).

Because of the hydrostatic and hydrodynamic characteristics of fluids, the walking mechanics in both environments is different. The various responses found in studies will be a consequence of methodological characteristics. While walking in water the buoyancy force reduces the apparent body weight reducing support forces, and the water drag force increases forces necessary to propel the body forward against water resistance (Orselli & Duarte, 2011). Water-based exercise enables a substantial quantity and quality of movements, often limited or restricted in land conditions. From the mechanical point-of-view, the shallow water walking has a lower stride frequency, higher stride length, and higher muscle activity of vastus medialis, rectus femoris, biceps femoris and gastrocnemius, while tibialis anterior presented similar activation, compared to land walking (Masumoto & Mercer, 2008). Walking at self-selected speed in water at high-chest level, the stride length is similar, but with a longer stride period and consequently lower speed, lower peak of the ground reaction force (Orselli & Duarte, 2011), and muscle activity of trunk and lower extremities compared to on-land walking (Masumoto & Mercer, 2008). Also, the ankle, knee and hip joint power, compressive and shear joint forces are lower during walk in water compared to land on ankle, knee and hip joints, while the angular displacement on lower limbs remain similar (Orselli & Duarte, 2011). However, walking at similar cardiorespiratory responses in water present lower stride frequency, stride length, and approximately 70% lower muscle activity in lower limbs (Masumoto & Mercer, 2008).

Although there are many studies showing the benefits of aquatic therapies and training programs in low back pain patients (Baena-Beato, Artero, et al., 2014; Baena-Beato, Delgado-Fernández, et al., 2014; Cuesta-Vargas, et al., 2012; Cuesta-Vargas, Buchan, & Arroyo-Morales, 2014), there are many differences between studies regarding the exercises programs, periodization, frequencies and others. Six weeks of aquatic exercises improve functional disability and reduce of pain, with higher improvement in pain intensity at 3 months follow-up if additionally to aquatic exercise they received classes of education on the neurophysiology of pain before intervention (Pires, Cruz, & Caeiro, 2015). High-intensity deep water running plus education and advice during 4 months is better than education and advice alone in reducing pain, disability and physical and mental health, and those improvements are maintained after 1-year follow-up (Cuesta-Vargas, et al., 2012).

An 8-week structured aquatic therapy exercise program can improve disability, quality of life, fitness and cardiovascular parameters, and pain reduction (Baena-Beato, et al., 2013). The frequency of intervention is also critical, three times per week being better than two times per week for improvements in disability, abdominal muscle endurance and heart rate at rest (Baena-Beato, et al., 2013). Otherwise, a 2-month intervention with five sessions of aquatic therapy per week showed improvements in disability, quality of life, fitness parameters and pain reduction in sedentary adults with chronic low back pain (Baena-Beato, Artero, et al., 2014). Also, 48% of changes in disability after aquatic exercise are predicted by changes in back pain intensity and abdominal muscular endurance in patients with chronic low back pain (Baena-Beato, Delgado-Fernández, et al., 2014), evidencing the importance of those factors in a therapeutic program. Therapeutic aquatic exercise can be a safe and effective treatment modality for patients with chronic low back pain (Baena-Beato, Delgado-Fernández, et al., 2014).

Collectively, the reduction on spinal compression, the analgesia during and following the aquatic exercise and others positive outcomes show the aquatic exercise therapy as a powerful method for individuals with low back pain. Considering the trunk more rigid on the transverse plane and changes in the motor program of low back pain walking due to pain, the aquatic intervention seems to be an interesting option and an effective proposal as a strategy to enhance health promotion and specifically to turn the gait mechanics to the healthy pattern. The mechanical link connecting these potential improvements remains to be established in subjects with low back pain.

3 Conclusion

The low back pain is the most common cause of disability among young adults and commonly idiopathic. Patients exhibit significant slower self-selected walking
speed, shorter strides and do not achieve physiological out-of-phase scapular-pelvis rotation. They present also more activation of trunk muscles and consequently, a more rigid movement of the upper body in the transverse plane. Although many therapies are effective, aquatic exercise therapies show additional positive results for disability, quality-of-life and functional outcomes. The potential enhancement of gait mechanics from aquatic interventions in low back pain individuals is promising but still unknown. Considering that the aquatic environment combines biomechanical effects, thermodynamic and the possibility to perform safely high-intensity exercise, we expect to find studies that combine different exercises prescription strategies, water depths, and manual therapies, in order to unravel the most positive therapeutic strategies for different painful conditions of the lumbar spine.

This study would not be possible without the assistance of the National Council for Scientific and Technological Development – CNPq/Brazil and LAPEX (023/2016). We are grateful to the Locomotion Group of the UniversidadeFederal do Rio Grande do Sul for discussions and comments.

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