Chapter II

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2.1 Introduction

Researcher has made efforts to locate related literature to this study from various sources which the research scholar had come across. The researcher reviewed the Journals, research dissertations, thesis, magazines, browsed websites which were related to his study. Review of literature helps the researcher create an association between the identified and unidentified, the earlier period and in attendance. In fact, the search and illuminations to the research in literature are the cause of inspiration and enlightenment to the research worker. In this chapter various reviews are noticed which will shed light on the effect of various exercise for physical fitness and other variables.

The related reviews were divided in to three groups:

- Reviews related to different physical activities as remedy for low back pain and other injuries.
- Reviews related to hydrotherapy as a remedy for different injuries.
- The investigations that support inversion therapy practices as a remedy for different injuries as well as low back pain.
The investigations that support hydrotherapy exercises as a remedy for low back pain.

Reviews related to reliability of the statistical tools used in this study

### 2.2 Reviews related to different physical activities as remedy for low back pain.

Sebnem (2007), investigated the effects of three therapeutic approaches in the chronic low back pain on pain, spinal mobility, disability, psychological state, and aerobic capacity. Sixty patients with chronic low back pain were randomized to three groups: group 1, aerobic exercise + home exercise; group 2, physical therapy (hot pack, ultrasound, TENS) + home exercise; group 3, home exercise only. Spinal mobility, pain severity, disability, and psychological disturbance of the patients were assessed before and after the treatment and at 1-month follow-up. Aerobic capacities of the patients were measured before and after treatment. All of the groups showed similar decrease in pain after the treatment and at 1-month follow-up, and there was no significant difference between the groups. In group 2, a significant decrease in Beck Depression Inventory scores was observed with treatment. At 1-month follow-up, group 1 and 2 showed significant decreases in General Health Assessment Questionnaire scores. In group 2, there was also a significant improvement in Roland Morris Disability scores. There were similar improvements in exercise test duration and the MET levels in all the three groups. All of the three therapeutic approaches were found to be effective in diminishing pain and thus increasing aerobic capacity in patients with chronic low back pain. On the other hand, physical therapy + home exercise was found to be more effective regarding disability and psychological disturbance.

According to Cambridge University, there are several exercises you can perform in a pool that can help ease your back pain. Many of these exercises require the use of a water noodle or other
floatation device that can be pushed into the water; these items increase resistance in the water and help to strengthen your back.

For the first exercise, hold on to a water noodle or a flotation device and push it under the water. Hold the water noodle under the water and gently bring it back to the surface. Repeat. You can also hold on to a water noodle and push it under the water while bending slightly to the left or the right (depending on which side of your body you are pushing the water noodle under). Alternate your hands and repeat the exercise. If you have two water noodles, keep one in each hand and alternate sides.

In addition to these exercises, simply walking around the pool is another way to get exercise that strengthens your back muscles (among other muscle groups), thereby helping to relieve pain. Simply do a few laps around the shallow end.

Sarah (2003), investigated current evidence for the type and quality of exercise being offered to chronic low back pain (CLBP) patients, within randomized controlled trials (RCTs), and to assess how treatment outcomes are being measured. A two-fold methodological approach was adopted: a methodological assessment identified RCTs of ‘medium’ or ‘high’ methodological quality. Exercise quality was subsequently assessed according to the predominant exercise used. Outcome measures were analyzed based on current recommendations. Fifty-four relevant RCTs were identified, of which 51 were scored for methodological quality. Sixteen RCTs involving 1730 patients qualified for inclusion in this review based upon their methodological quality, and chronicity of symptoms; exercise had a positive effect in all 16 trials. Twelve out of 16 programmers incorporated strengthening exercise, of which 10 maintained their positive results at follow-up. Supervision and adequate compliance were common aspects of trials. A
wide variety of outcome measures were used. Outcome measures did not adequately represent the guidelines for impairment, activity and participation, and impairment measures were over-represented at the expense of others. Despite the variety offered, exercise has a positive effect on CLBP patients, and results are largely maintained at follow-up. Strengthening is a common component of exercise programs, however, the role of exercise co-interventions must not be overlooked. More high quality trials are needed to accurately assess the role of supervision and follow-up, together with the use of more appropriate outcome measures.

Balogh (2005), mentioned that low back pain is among the most prevalent musculoskeletal disorders affecting a large proportion of the population during their lifetime. Although small in number, all controlled studies published on this subject have demonstrated the benefits of balneotherapy. This present study was undertaken to compare the effects of hydrotherapy with mineral water vs. tap water on low back pain. Patients and Methods: A single-blind clinical study was carried out to appraise the therapeutic efficacy of reduced sulphurous water on 60 patients with low back pain. 30 subjects took baths in reduced sulphurous mineral water, whereas the other 30 patients used modified tap water of matching odor. Parameters determined at baseline, after balneo-hydrotherapy, and at the end of the 3-month follow-up period included the results of the Visual Analogue Scale (VAS) score, the modified Oswestry index, mobility of the spine, atelic posture, tenderness of the par vertebral muscles on palpation, the dose requirements for analgesics, and the efficacy assessed by the investigators and by the patients. Results: Bathing in mineral water resulted in a statistically significant improvement. This was reflected by the VAS (p < 0.01) and manifested by the mitigation of muscle spasm (p < 0.01), the alleviation of local tenderness (p < 0.01), the enhanced flexion-extension and rotation of the spine (p < 0.01) as well as by the improvement of the Schober’s index (p < 0.01). All these beneficial changes persisted
as long as 3 months after the completion of balneotherapy. By contrast, hydrotherapy with tap water resulted only in the temporary improvement of just a single parameter: the VAS score improved significantly (p < 0.01). Conclusions: Balneotherapy in itself can alleviate low back pain. As demonstrated by this study, the analgesic efficacy and improvement of mobility accomplished by the use of mineral water is significantly superior to that afforded by hydrotherapy with tap water. Our results clearly establish the beneficial effects of mineral water. Moreover, it is a valuable adjunct to other forms of physical treatment as well as to pharmacotherapy.

The purpose of Anna (2008)\textsuperscript{4}, review was to evaluate the literature on the effectiveness of physiotherapy exercises in reducing chronic low back pain (CLBP). A systematic search of the medical databases was performed, with 64 articles retrieved. After the exclusion criteria were applied, 15 randomized controlled trials (RCTs) evaluating physiotherapy delivered exercise programs to patients with CLBP remained. A methodological quality assessment was performed, showing the included studies to have medium to high quality. Prescribed physiotherapy exercises included general fitness and aerobic exercises, flexibility regimes, stretches, muscle strengthening and spinal stabilizing exercises. These interventions were compared with each other as well as surgical stabilization, yoga, hydrotherapy, back care education booklets and placebo groups. Overall, physiotherapy prescribed exercise programs were found to be effective in reducing pain in patients with CLBP. However, there was no consensus on a specific technique or exercise format being consistently superior to other interventions.

Furlan (2002)\textsuperscript{5}, mentioned that low back pain (LBP) is one of the most common and costly musculoskeletal problems in modern society. Proponents of massage therapy claim it can
minimize pain and disability and speed return-to-normal function. To assess the effects of massage therapy for non-specific LBP. We searched MEDLINE, Embase, Cochrane Controlled Trials Register, Health STAR, CINAHL, and dissertation abstracts through May 2001 with no language restrictions. References in the included studies and in reviews of the literature were screened. Contact with content experts and massage associations was also made. The studies had to be randomized or quasi randomized trials investigating the use of any type of massage (using the hands or a mechanical device) as a treatment for nonspecific LBP. Two reviewers blinded to authors, journals, and institutions selected the studies, assessed the methodology quality using the criteria recommended by the Cochrane Collaboration Back Review Group, and extracted the data using standardized forms. The studies were analyzed in a qualitative way because of heterogeneity of population, massage technique, comparison groups, timing, and type of outcome measured. Nine publications reporting on eight randomized trials were included. Three had low and five had high methodological quality scores. One study was published in German, and the rest, in English. Massage was compared with an inert treatment (sham laser) in one study that showed that massage was superior, especially if given in combination with exercises and education. In the other seven studies, massage was compared with different active treatments. They showed that massage was inferior to manipulation and transcutaneous electrical nerve stimulation; massage was equal to corsets and exercises; and massage was superior to relaxation therapy, acupuncture, and self-care education. The beneficial effects of massage in patients with chronic LBP lasted at least 1 year after the end of the treatment. One study comparing two different techniques of massage concluded in favor of acupuncture massage over classic (Swedish) massage. Massage might be beneficial for patients with sub-acute and chronic nonspecific LBP, especially when combined with exercises and education. The evidence
suggests that acupuncture massage is more effective than classic massage, but this needs confirmation. More studies are needed to confirm these conclusions, to assess the effect of massage on return-to-work, and to measure longer term effects to determine cost-effectiveness of massage as an intervention for LBP.

The effect of spa therapy on chronic low back pain (LBP) was assessed by Guillemev (1998) in a randomized trial comparing patients undergoing a 3-week therapy program in a spa resort in France (n = 50) with patients receiving ambulatory care (n = 52). After 3 weeks, patients in the spa group had significant improvement in their spine mobility and functional score (Waddell index) and a reduction in their daily duration of pain, pain intensity and drug consumption. The long-term effect was assessed after 9 months and showed continued reduction in pain and drug consumption, and improvement in spine mobility but no longer in functional score which returned to baseline level. It is concluded that spa therapy has a positive short-term and a moderate long-term effectiveness on chronic LBP.

Furlan (2009), assessed the effects of massage therapy for nonspecific low back pain. Low back pain is one of the most common and costly musculoskeletal problems in modern society. Proponents of massage therapy claim it can minimize pain and disability, and speed return to normal function. They searched MEDLINE, EMBASE, and CINAHL from their beginning to May 2008. We also searched the Cochrane Central Register of Controlled Trials (The Cochrane Library 2006, issue 3), Health STAR and Dissertation abstracts up to 2006. There were no language restrictions. References in the included studies and in reviews of the literature were screened. The studies had to be randomized or quasi-randomized trials investigating the use of any type of massage (using the hands or a mechanical device) as a treatment for nonspecific low
back pain. Two review authors selected the studies, assessed the risk of bias using the criteria recommended by the Cochrane Back Review Group, and extracted the data using standardized forms. Both qualitative and meta-analyses were performed. Thirteen randomized trials were included. Eight had a high risk and 5 had a low risk of bias. One study was published in German and the rest in English. Massage was compared to an inert therapy (sham treatment) in 2 studies that showed that massage was superior for pain and function on both short- and long-term follow-ups. In 8 studies, massage was compared to other active treatments. They showed that massage was similar to exercises, and massage was superior to joint mobilization, relaxation therapy, physical therapy, acupuncture, and self-care education. One study showed that reflexology on the feet had no effect on pain and functioning. The beneficial effects of massage in patients with chronic low back pain lasted at least 1 year after the end of the treatment. Two studies compared 2 different techniques of massage. One concluded that acupuncture massage produces better results than classic (Swedish) massage and another concluded that Thai massage produces similar results to classic (Swedish) massage. Massage might be beneficial for patients with sub-acute and chronic nonspecific low back pain, especially when combined with exercises and education. The evidence suggests that acupuncture massage is more effective than classic massage, but this need confirmation. More studies are needed to confirm these conclusions, to assess the impact of massage on return-to-work, and to determine cost-effectiveness of massage as an intervention for low back pain.

Morshedí (2009) 8, mentioned that low back pain is a major health problem with enormous economic and social costs. The toll that bears on individuals, families and society make the successful management of this is common. Despite its widespread use, the effectiveness of LLLT (low level laser therapy) is still controversial. Traditional treatments include drugs,
physical treatment, back exercises and education, but they are not always completely helpful. Many people seek alternative treatments, such as LLLT. Therefore main goal of this study is determine the effect of LLLT on the intensity of chronic LBP. This randomized clinical trial (RCT) has been done at medical laser center of Pastor-no hospital in Tehran. 30 patients with chronic LBP (because of lumbago) in rhea range of 30-60 years old were randomly divided to the laser treatment group and laser placebo group. Both of two groups went under treatment for 3 times in a week for 4 weeks. Applied laser in laser treatment group was continuous red light laser and pulse infrared with Mustang system with 890nm wavelength and 4-6 J/cm² dose (energy), and was irradiated on the mentioned vertebral bodies and spinouts processes. Treatment in laser placebo group was done with off laser. Efficacies of treatment were evaluated with pain questionnaire and thermograph. Data was analyzed with chi-square (χ²) and t-student statistical tests.

Ayse's (1999), investigated and compared the efficacy of aerobic exercises versus strengthening, stretching and mobilization exercises in patients with sub-acute or chronic low back pain. Forty patients were recruited for the study and randomly allocated to two groups. All patients were evaluated at admission, mid-treatment and termination of the program by visual analog scale (VAS), face scale, weekly analgesic intake and Million visual analog scales for pain. They were also scored by Roland-Morris scale and Oswestry scale for functional impairment. Beck depression inventory was used to evaluate depression and lumbar range of motion was measured by inclinometry, Schober, fingertip to floor distance. The aerobic exercise group was also evaluated for VO2max and anaerobic threshold levels. Both groups showed significant improvement in all parameters at termination. Comparison between groups showed a
higher significant improvement in depression and functional improvement parameters in the
group given strengthening, stretching and mobilization exercises by physiatrist.

The back is an intricate structure of bones, muscles, and other tissues that form the posterior part
of the body’s trunk, from the neck to the pelvis. The centerpiece is the spinal column, which
not only supports the upper body’s weight but also houses and protects the spinal cord, the
delicate nervous system structure that carries signals that control the body’s movements and
convey its sensations. Stack on top of one another are more than 30 bones, the vertebrae, which
form the spinal column, also known as the spine. Each of these bones contains a roundish hole
that, when stack in register with all the others, creates a channel that surrounds the spinal cord.
The spinal cord descends from the base of the brain and extends in the adult to just below the rib
cage. Small nerves (roots) enter and emerge from the spinal cord through spaces between the
vertebrae. Because the bones of the spinal column continue growing long after the spinal cord
reaches its full length in early childhood, the nerve roots to the lower back and legs extend many
inches down the spinal column before exiting.

This large bundle of nerve roots was dubbed by early anatomists as the cauda equina, or horse’s
tail. The spaces between the vertebrae are maintained by round, spongy pads of cartilage called
intervertebral discs that allow for flexibility in the lower back and act much like shock absorbers
throughout the spinal column to cushion the bones as the body moves. Bands of tissue known as
ligaments and tendons hold the vertebrae in place and attach the muscles to the spinal column.
The spine has four regions; the seven cervical(C1–C7), the 12 thoracic(T1–T12), the five lumbar
vertebrae(L1–L5), which we know as the lower back, and the sacrum and coccyx, a group of
bones fused together at the base of the spine. The lumbar region of the back, where most back pain is felt, supports the weight of the upper body. On the other hand, one important mechanical function of the lumbar spine is to support the upper body by transmitting compressive and shearing forces to the lower body during the performance of everyday activities. To enable the successful transmission of these forces, mechanical stability of the spinal system must be assured. Anatomically, the lumbar spine in vivo during various three-dimensional dynamic tasks included a rigid pelvis, ribcage, five vertebrae, 90 muscle fascicles and lumped parameter discs, ligaments and facets. It appears that there is an ample stability safety margin during tasks that required a high muscular effort. However, lighter tasks present a potential hazard of spine buckling, especially if some reduction in passive joint stiffness is present. Several hypotheses on the mechanism of injury associated with low loads and etiology of chronic back pain are presented in the context of lumbar spine stability, (Cholewicki, and McGill, 1999). By the way LBP is a common symptom of musculoskeletal disorder or disorders involving the lumbar vertebrae. It can be acute, sub-acute or chronic in its clinical presentation. Typically, the symptoms of low back pain show significant improvement within two or three months from its onset. In a significant number of individuals, low back pain tends to be recurrent in nature with waxing and disappearing quality to it. In a small proportion of sufferers this condition can become chronic. Population studies show that back pain affects most adults at some stage in their life and accounts for more sick leave and disability than any other single medical condition (Hutch, 2008).

A program of back exercises in hydrotherapy was developed for a group of people with chronic back pain. As part of management practice, the group was monitored before and during the program. Findings demonstrated a reduction in pain levels and an improvement in quality of life.
The value of the sufferers reassuming control of their treatment programs and the advantages of working in groups are debated. The financial considerations of hiring out National Health Service facilities to self-help groups are discussed.\textsuperscript{13}

Hydrotherapy for OA of the hip has rarely been evaluated in controlled studies. Forty-seven patients with OA of the hip were followed for 18 weeks. Patients were randomly allocated either to a regimen of home exercises or to twice weekly hydrotherapy for 6 weeks in addition to home exercises. There was an improvement seen in both subjective and objective measures in both groups with treatment. There was no significant difference between the two groups. Response to treatment appeared independent of age, sex and radiological severity. We conclude that for most patients, a carefully graded and supervised regimen of home exercises is beneficial and there is little benefit in adding hydrotherapy to this regimen.\textsuperscript{13}

2.3 Reviews related to hydrotherapy as a remedy for different injuries

Hydrotherapy, (2009)\textsuperscript{14} is the use of water to heal and ease a variety of ailments. Hydrotherapy is the most beneficial system of restoring normal functions in the body. It is employed to help balance metabolism. Hydrotherapy (also called aqua therapy or water therapy) involves using the healing powers of water to treat back pain. Water Therapy has been used for thousands of years to treat a variety of diseases and pain syndromes. Water therapy is commonly used by physical therapists as part of a complete therapy routine. Water Therapy works for 2 main reasons. First, by submerging yourself in water, you are eliminating the strong pull of gravity on your body. This can reduce pressure on the back and therefore relieve pain in compressed nerves. Second,
the temperature of water, hot or cold, can cause either increased circulation or reduced circulation, depending which is indicated for your particular pain problem.

**Lund (2008)**, randomized 79 patients with knee osteoarthritis to: 1) aquatic exercise (n = 27), 2) land-based exercise (n = 25) or 3) control (n = 27). Both the aquatic and land-based exercise programs consisted of the following parts: warm-up, strengthening/endurance exercise, balance exercise and stretching exercise. Each session lasted 50 min, comprising 10 min warm-up, 20 min resistance exercises, 10 min balance and stabilizing exercises, 5 min lower limb stretches and 5 min cool-down period. Both exercise interventions were carried out for 8 weeks with 2 sessions per week. No effect was observed immediately after exercise cessation (8 weeks). At 3-month follow-up a reduction in VAS pain was observed only in the land-based exercise group compared with control (–8.1 mm, 95% confidence interval –15.4 to –0.4; p = 0.039). There were no differences between groups for Knee Injury and Osteoarthritis Outcome Score questionnaire. There were no improvements following aquatic exercise. Only land-based exercise showed some improvement in pain and muscle strength compared with the control group, while no clinical benefits were detectable after aquatic exercise compared with the control group.

**Sylvester (1990)**, randomized 14 patients with hip osteoarthritis to: 1) hydrotherapy or: 2) short wave diathermy and exercises. Both groups performed hip and walking exercises for 30 minutes twice a week for six weeks. There were no significant differences between the groups prior to treatment. Following treatment, pain had decreased significantly (p < 0.02) in both groups. After
treatment, there were no significant differences between the two groups with regards to pain, functional ability, life satisfaction, gait and range of motion.

Silva in (2008)\textsuperscript{17}, randomly assigned 64 subjects with osteoarthritis of the knee to one of two groups that performed exercises for 18 weeks: a water-based exercise group and a land-based exercise group. The outcome measures included a visual analog scale (VAS) for pain in the previous week, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), pain during gait assessed by a VAS at rest and immediately following a 50-foot (15.24-m) walk test (50FWT), walking time measured at fast and comfortable paces during the 50FWT, and the Lequesne Index. Measurements were recorded by a blinded investigator at baseline and at 9 and 18 weeks after initiating the intervention. Based on inspection of the 95\% confidence intervals presented in Table 3, 4 and 5 in the publication (22), there were no significant differences between groups in outcomes measured at 9 and 18 weeks.

Wang in (2007)\textsuperscript{18}, randomized 38 participants from community sources to a 12 week aquatic program or a non-exercise control condition. The 12-week aquatic program consists of warm up, flexibility and strength training, and cool down. The exercises are divided into six sections, as shown in Table 1. The 50-minutes class focuses on joints in the trunk, shoulders, elbows, wrists, fingers, hip, knees, ankles and toes, and emphasize muscle groups of upper and lower limbs. Control participants were asked to continue their physical activity as usual and offered an opportunity to participate in the aquatic program at the end of the trial. The aquatic exercise group responded to exercise. A more appropriate and relevant control group would have been dry land exercise of the same duration, intensity and frequency.
Belza in (2002), randomized 249 adults with osteoarthritis to: 1) a 20-week Arthritis Foundation Aquatic exercise Program (n=125) or 2) a wait-list control group (n=124). Participants in the control group were asked to follow their usual pattern of activities and abstain from starting new exercise programs for the duration of the study, after which they were invited to attend an AFAP free of charge. Participants allocated to receive exercise responded to exercise. This trial does not provide an objective comparison between water based exercises and the appropriate comparator group, gentle land based exercises. No inferences can be drawn regarding the added value of conducting the exercises in water.

Hinman in (2007), randomized 71 volunteers with symptomatic hip OA or knee OA to: 1) an aquatic physical therapy group (n=36), or; 2) a wait-list control group (n=35). The aquatic physical therapy program comprised functional weight bearing and progressive exercises provided twice weekly (45–60 minutes each) for 6 weeks. An experienced aquatic physical therapist individually instructed participants in the hydrotherapy pool (water temperature 34°C), with a maximum of 6 participants per session. Quality of movement was emphasized, and the therapist palpated the lower-limb musculature to ensure appropriate contraction throughout the exercises. The control group did not receive any additional physical therapy over the 6-week trial; however, these participants were offered the intervention following the 6-week assessment to minimize dropouts from this group. Control participants were instructed to continue with their usual daily activities and medication regimen and not commence any new exercise programs or treatments for their OA affected joints. The findings demonstrated that a 6-week, twice-weekly exercise program leads to reduced pain and joint stiffness as well as improved physical function,
hip muscle strength, and quality of life in people with OA. Due to the lack of an active control group, it is difficult to draw inferences from these results.

Soumi in (2000)\textsuperscript{20}, randomized women to participate in: 1) a pool exercise group (n=20) or; 2) a no exercise control group (n=10). The pool exercise group received the Arthritis Foundation Aquatic Program three times a week for six weeks in a pool heated to between 85-87°F. The control group received no intervention and was asked to refrain from taking up any additional exercise during the study period. Three patients randomized to the pool exercise group ‘dropped out’ and outcomes are not reported for these patients. The intervention group, which received more exercise than the control group responded to exercise. Hip abduction isometric strength and range of motion were increased significantly in the exercise group however there were no changes over time in shoulder abduction isometric strength or range of motion.

Eversden in (2007)\textsuperscript{21}, randomized 115 patients with rheumatoid arthritis to: 1) a weekly 30-minute session of hydrotherapy or; 2) similar exercises on land for 6 weeks. The exercise content in each group was similar and exercises were tailored to each individual's ability. Participants warmed up by mobilizing and stretching. The core exercises were repeated each week and focused on joint mobility, muscle strength and functional activities. Eleven patients allocated land exercise failed to complete the six week course compared with four patients allocated to hydrotherapy (p = 0.09). Significantly more patients treated with hydrotherapy reported feeling much better or very much better than the patients treated with land exercise (87% vs 47.5%, p < 0.001 Fisher's exact test) immediately on completion of the treatment program. This perceived benefit was not reflected by differences between groups in 10-metre walk times, functional
scores, repeatable quality of life measures (Health Assessment Questionnaire, Euro Qual Visual Analog Scale), measures of health status (Euro Qual 5D utility score), or pain measured by a Visual Analog Scale.

Volaklis in (2007)\textsuperscript{22}, examined the effects of combined resistance and aerobic training on land versus combined resistance and aerobic training in water. Thirty four subjects with coronary artery disease were randomly assigned to: 1) land exercise (n = 12), 2) water exercise (n = 12), or 3) control (n = 10) groups. The water exercise program was conducted in a heated pool (depth 1.20 m) at water temperatures between 28°C and 30°C and consisted of 2 weekly aerobic sessions (at 50%-70% of maximal heart rate achieved during symptom limited grade exercise test) and 2 weekly sessions of resistance training (60%-80% of the maximal number of repetitions performed in each exercise at baseline). All sessions lasted 60 min and included a warm up period (10 minutes), the main program (30-40 minutes), and a cool down period (10 minutes). The land exercise program consisted of 2 weekly aerobic sessions and 2 weekly sessions of resistance training. Both aerobic and strength exercise lasted 60 minutes and included a warm-up period (10 minutes), the main program (30-40 minutes) and a cool down period (10 minutes). The exercise intensity of the aerobic program was 60% to 80% of the maximal heart rate achieved during a symptom-limited grade exercise test. After 4 months of training, analysis of covariance revealed that body weight and sum of skin folds were lower for both exercise groups than for the control group. Patients who trained in water improved exercise time and maximum strength in a similar manner compared to the patients who trained on land. Both exercise groups significantly reduced total cholesterol and triglycerides, but there were no differences among exercise groups. The results of the present study show that both the water and
land exercise programs were effective at increasing exercise time, muscular strength, body composition, and improving lipid profile in patients with CAD.

**2.4 Reviews related to inversion therapy practices as a remedy for different injuries:**

Twenty persons with chronic low back pain participated in a clinical study to evaluate the effects of gravity traction. Each subject was instructed in the use of three devices, two for inversion and one for upright suspension traction. Baseline pulse and rate blood pressure were recorded before and after traction. Periods of traction did not exceed 20 minutes. The order of use of the devices was randomized. Each participant was monitored for significant side effects and was questioned to determine which device was best tolerated, easiest to use, or caused changes in back symptoms. Lateral lumbar spine radiographs were taken with the subject in the standing position and after varying periods of inversion. Observations included the following: An average increase in blood pressure of 17.2 systolic (range 4-34) and 16.4 diastolic (range 2-50) while in the inverted position. No significant physiologic changes of blood pressure or pulse were observed in patients using GLR suspension traction; distraction of the lower lumbar intervertebral spaces (range, 0.3 to 4.0 mm) with inverted traction in all cases; side effects including per orbital and pharyngeal petechial (one patient), persistent headaches (three patients), persistent blurred vision (three patients), and contact lenses discomfort (one patient); and improvement of low back symptoms in 13 of the 16 symptomatic patients. Although these devices make lumbar traction practical in a home setting, their use should be under medical supervision because of possible side effects.23
Inversion traction therapy has received only modest scientific investigation. No study to date, has investigated a complete range of physiological parameters pertinent to inversion therapy. A set of physiological parameters including cardiovascular, biomechanical and radiographic were studied in a normal population using the Inver chair. Our results demonstrated a significant increase of forward trunk flexion, a general reduction of Para spinal EMG activity, a significant level of distraction of the L4-5 and L5-SJ disc spaces, as well as a lack of change in heart rate and blood pressure. These findings establish the physiological basis for the clinical effects of Inver chair Therapy and for its appropriate clinical utilization.

Inversion therapy has been used to relieve back pain as early as 400 BC when Hippocrates, the Father of Medicine, strung up a patient on a ladder with ropes and pulleys and allowed gravity to do its work. The concept of inversion was not widely recognized in the United States, however, until Dr. Robert Martin (a California osteopath, chiropractor and medical doctor) introduced the “Gravity Guidance System” in the 1960’s. This revolutionary concept addressed the effects of gravity on the human body, the simple solution of inversion therapy, and the resulting benefits.

Dr. Martin had a “marketable personality.” He was devoted to communicating the benefits of postural exchange including inversion, and the public responded well to his sincerity and honesty. Dr. Martin appeared on talk shows, and was featured in popular publications like The Wall Street Journal. Dr. Robert Martin, Jr. published a book in the late 1970’s. Together with the Gravity Guidance Inversion Table, the program caught on, experiencing increasing success. This encouraged other companies to enter the inversion market-products like the Bud Leach table and the BackSwing
emerged. Gravity boots were popularized by the 1980 movie “American Gigolo” starring Richard Gere. By 1982, the inversion market had soared to over $70 million, with literally thousands of people incorporating inversion regularly into their lifestyle.

Success comes with a price, however. Before soon, over forty manufacturers were producing inversion products. There was little differentiation between the products, which caused price wars among the companies. Some manufactures sacrificed quality so that they could offer cheaper products. The lack of attention to quality resulted in product failures, causing serious, sometimes deadly, harm to consumers.

Also, a medical study published in 1983 by Dr. Goldman and colleagues showed that inverted patients experienced an increase in blood pressure and internal eye pressure. The media widely reported the study, warning that stroke was a potential result of inversion. Two years following the inversion study, Dr. Goldman reversed his original position, stating, “New research shows that you are at no more of a stroke risk hanging upside down than if you are exercising right side up.” More in-depth research found that the body actually has mechanisms that prevent damage from hanging upside down. In fact, while oscillating (inverting with movement), some of the patients’ blood pressure actually dropped a few points.

Experienced inverters also showed slower heart rates while inverted than when upright. Dr. Goldman stated that the warnings to the public about the dangers of inversion were “grossly inflated” and that in the 15 years these devices have been in use, there has not been one single
stroke or cardiovascular incident documented. Note from Teeter Hang Ups: After 36 years, to the best of our knowledge this statement still remains valid.

Other universities, including Marquette, Iowa, and Portland studied inversion during this time, with results that vindicated Inversion as no more dangerous than other common fitness activities. Unfortunately, the damage had already been done. The poor quality equipment combined with misunderstandings of health risks resulted in a decline of consumer confidence in inversion products. Inversion went from a multi-million dollar market to one that struggled to survive. The use of Inversion therapy shrank to virtually exclusive use by a few “in the know”, including chiropractors, physical therapists, sports trainers and professional athletes. Of the forty plus manufacturers in business in the early 1980’s, Hang Ups was the only company to continuously promote inversion products to present.\textsuperscript{24}

\section*{2.5 Reviews related to hydrotherapy exercises as a remedy for low back pain.}

An extensive review by Kool in (2004)\textsuperscript{25}, investigated whether land-based exercise alone or as a part of a multidisciplinary treatment reduces sick leave in patients with nonspecific, non-acute, low back pain. The reviewers concluded that there is strong evidence that land-based exercise significantly reduces sick days during the first follow-up year. Since land-based exercise is accepted to be effective, it serves as the appropriate control intervention against which to evaluate the effectiveness of hydrotherapy.

Yozbatiran in (2004)\textsuperscript{26}, randomized 30 patients to: 1) aquatic exercise (n=15) or; 2) land-based exercise (n=15). Both groups followed similar programs, which included warm-up, stretching, a
circuit of 15 progressive exercises, cool down with light stretching and light aerobic exercise. Sessions were conducted 3 times a week for 4 weeks. No significant differences were found between the groups with regards to aerobic fitness, motor fitness (single leg balance test with eyes open or closed), and musculoskeletal fitness, pain reports, Sorensen and Oswestry low back pain disability index scores.

Sjogren in (2001)\textsuperscript{27}, sequentially allocated’ sixty subjects in order of presentation with chronic low back pain to either: 1) hydrotherapy treatment or; 2) land treatment groups. Due to the sequential allocation process, this trial should be regarded as pseudo- or quasi-randomized. Pseudo-randomized trials may be subject to severe forms of selection bias and allocation bias, and may over-estimate treatment effects by up to 40%. Both the land and the hydrotherapy exercise programs consisted of two group sessions per week for a period of six weeks. Each subject had to participate in the full twelve sessions over this period. If a session was missed an alternative session was arranged and if more than two consecutive sessions were missed the subject was withdrawn from the study. Twenty-eight subjects from each group attended all treatment and assessment sessions. Results indicated that both groups improved significantly in functional ability and in decreasing pain levels. Thoracolumbar mobility did not improve significantly in either group. Overall there was no significant difference found between the two types of treatment.

McIlveen in (1998)\textsuperscript{28}, randomized 109 adults with lower back pain (LBP) or back and leg pain of more than three months duration to either: 1) hydrotherapy or; 2) control (delayed hydrotherapy) group. Each hydrotherapy session was led by experienced pool volunteers with
additional training in delivering the prescribed 20 spinal exercises. Ten repetitions of each prescribed exercise were included during each session. If a subject missed a session, an extra one was arranged. Any subject who missed more than one session in the four-week period was withdrawn from the study. The control group received no intervention during the study period. They were placed on a ‘waiting list’ for hydrotherapy. Forty-five 45 people in the experimental group, and 50 people in the control group completed the trial. Significantly more people in the exercise group reported a change in functional status, as measured by the Oswestry Disability Questionnaire score (p=0.04). Differences between the experimental and control groups were not significant for other measures of pain, light touch, reflexes, strength, or for the ranges of flexion, extension and passive straight leg raise. It is difficult to draw inferences from these results because the control group did not receive any active intervention.

Schrepfer in (2008)\(^29\), randomized 49 patients with chronic low back pain to: 1) deep water walking and 2) deep water hanging. This study did not identify any significant differences between hydrotherapy groups. it also did not include a land-based exercise group as a control.

Smit (2000)\(^30\), In a pilot study which investigated the effectiveness of hydrotherapy in the management of lumbar spondylosis, a group of 20 people suffering from chronic lower back pain were given a four week trial of hydrotherapy treatment, consisting of three individual session each week. The group was assessed both before and after the course of hydrotherapy and each person was also sent a questionnaire three months after the conclusion of their treatment. Results demonstrated a reduction in pain levels and suggested that thoraco-lumbar mobility could be improved, especially if the range was less than normal before treatment. Results from
the questionnaires showed that the beneficial effects from hydrotherapy may not be long lasting, suggesting the need for continuing session to maintain improved mobility and reduced pain levels. Further studies including a matching control group are indicated to confirm these results.

Waller in (2009)\(^1\), examined the effectiveness of therapeutic aquatic exercise in the treatment of low back pain. A systematic review Methods: A search was performed of PEDro, CINAHL (ovid), PUBMED, Cochrane Controlled Trials Register and Sport Discus databases to identify relevant studies published between 1990 and 2007. Outcomes: Subjective assessment scale for pain (e.g. visual analogue scale) and number of work days lost as a direct result of low back pain. Methodological quality was assessed using the PEDRO scale and the SIGN 50 assessment forms. Thirty-seven trials were found and seven were accepted into the review. Therapeutic aquatic exercise appeared to have a beneficial effect, however, no better than other interventions. Methodological quality was considered low in all included studies. The heterogeneity among studies, in numbers of subjects, symptoms durations, interventions and reporting of outcomes, precluded any extensive meta-analysis of the results. There was sufficient evidence to suggest that therapeutic aquatic exercise is potentially beneficial to patients suffering from chronic low back pain and pregnancy-related low back pain. There is further need for high-quality trials to substantiate the use of therapeutic aquatic exercise in a clinical setting.

You-sin kim in (2010)\(^2\) compared the effects of aquatic backward locomotion exercise and progressive resistance exercise with a machine on lumbar extension strength in patients who have undergone diskectomy for a lumbar disk herniation. Male patients (N=30) with disk herniation at spinal levels L3 to S1 completed this study as subjects. After the diskectomy for a
lumbar disk herniation, all patients had 6 weeks of rest time. At the end of the rest period, the aquatic backward locomotion exercise and progressive resistance exercise groups, respectively, started first 6 weeks of underwater training and lumbar extension training twice per week. After completion of the first 6-week training, subjects participated in second 6-week training. The control (CON) group did not undergo any training. For each test, maximum voluntary isometric lumbar extension strength was measured in 7 trunk positions (72°, 60°, 48°, 36°, 24°, 12°, and 0° of the trunk angle). The progressive resistance exercise and aquatic backward locomotion exercise groups showed increases in lumbar extension strength after the first 6-week training, although they were not statistically different from the CON group. After a second 6-week training, the progressive resistance exercise and aquatic backward locomotion exercise groups showed statistically significant increases in their strength levels as compared with the CON group. After the detraining period, the strength levels of the progressive resistance exercise and aquatic backward locomotion exercise groups did not statistically differ from the CON group. After the retraining period, the progressive resistance exercise and aquatic backward locomotion exercise groups showed increases in their strength levels, which were different from that of the CON group.

Dundar in (2009)\(^3\), compared the effectiveness of aquatic exercise interventions with land-based exercises in the treatment of chronic low back pain (CLBP). Land-based exercise and physiotherapy are the main treatment tools used for CLBP. Clinical experience indicates that aquatic exercise may have advantages for patients with musculoskeletal disorders. A total of 65 patients with CLBP were included in this study. Patients were randomly assigned to receive aquatic exercise or land-based exercise treatment protocol. Aquatic exercise program consisted of 20 sessions, 5 x per week for 4 weeks in a swimming pool at 33 degrees C. Land-based
exercise (home-based exercise) program were demonstrated by a physiotherapist on one occasion and then they were given written advice. The patients were assessed for spinal mobility, pain, disability, and quality of life. Evaluations were performed before treatment (week 0) and after treatment (week 4 and week 12). Results showed that in both groups, statistically significant improvements were detected in all outcome measures (except modified Schober test) compared with baseline. However, improvement in modified Oswestry Low Back Pain Disability questionnaire and physical function and role limitations due to physical functioning subpart of Short-Form 36 Health Survey were better in aquatic exercise group (P < 0.05). It was concluded that a water-based exercises produced better improvement in disability and quality of life of the patients with CLBP than land-based exercise.

2.6 Reviews related to reliability of the statistical tools used in this study

2.6.1 Reviews related to reliability of the SLR test

Andrew in (2004)\(^3\), determined the relationship between hamstring injury and hamstring length in a prospective analysis of adolescent football players as well as assessing the impact of age and test type upon hamstring length. Method: One hundred and eleven footballers (9–19 years old) volunteered after subject and parental/guardian consent. Hamstring muscle length was assessed at baseline via; modified sit-and-reach (mSAR), straight leg raise (SLR), active knee extension (AKE), passive knee extension (PKE) and seated knee extension (SKE). Medical staff recorded hamstring injuries during the following competitive season. Results: During the study 16 subjects reported 20 hamstring strains. Data for all hamstring muscle length tests were not significantly different (PO0.01) between injured and non-injured legs (e.g. SLR 73.3G7.08 vs. 74.3G7.58) or between injured and non-injured subjects (e.g. SLR right leg 74.3G7.98 vs.
76.9G9.88, SLR left leg 73.8G5.98 vs. 74.7G9.38). Data for hamstring length across age groups significantly declined (P<0.01) for SLR, AKE, PKE and SKE (e.g. SLR left leg 78.1G10.88 vs. 70.6G4.08, SLR right leg 83.0G8.88 to 71.4G4.18) compared to a significant (P<0.01) rise in mSAR test (15.7G3.6 cm vs. 29.1G9.9 cm). Moderate to strong associations existed between AKE, PKE and SKE (r=0.55–0.87), whereas mSAR was only weakly correlated with other tests (r<0.01 to K0.27).

Conclusion: Hamstring injuries are common in young footballers and are not overtly related to significant decrements in hamstring muscle length, although individual case analysis may be advisable. Estimates of apparent hamstring muscle length differ dependent on age and on the test employed.

Jan in (2002)\textsuperscript{35}, assessed the validity of the active straight leg raise test as a disease severity scale for patients with posterior pelvic pain after pregnancy. Various diagnostic tools are used to measure disease severity in patients with posterior pelvic pain after pregnancy, but simple tests with high reliability and validity still are needed. The investigation was performed with 200 women who had posterior pelvic pain after pregnancy. The validity of the active straight leg raise test as a severity scale was investigated by comparing the test score with the medical history, scores on self-reported disability scales, pain and tiredness, and pain provocation tests. The usefulness of the active straight leg raise test as a severity scale was compared with that of the Québec Back Pain Disability Scale. The influence of several demographic and anthropometric variables on the active straight leg raise score was investigated. The active straight leg raise score ranged from 0 to 10 and correlated as expected with all severity scales. The correlation between the scores on the active straight leg raise test and the Québec Back Pain Disability Scale was 0.70. No association was found between the active straight leg raise score and age, parity,
duration of the postpartum period, height, or weight. The active straight leg raise test can be recommended as a disease severity scale for patients with posterior pelvic pain after pregnancy.

Chang in (2002)\textsuperscript{36}, compared three instruments in the assessment of the straight-leg-raising test (SLR): a standard plastic goniometric, a flex meter, and a tape measure. Hip flexion angles at the initial point of pelvic tilt were measured in 10 healthy subjects. All three methods showed excellent intersession reliability with alpha coefficients greater than .94. The intersession reliabilities were identical for the goniometry and the flex meter (.88) and were higher than the reliability of the tape measure (.74). The tape measure had improved intersession reliability (.93) when a distance was used for calculation of the angle. Significantly lower hip flexion angles were obtained with the trigonometric method through use of tape measures than from use of either of the other two instruments. The flex meter is recommended for use in assessment of passive straight leg raise because it permits measurement by a single therapist without assistance.

Kimberly in (2005)\textsuperscript{37}, mentioned that hamstring injuries are extremely debilitating and affect many athletes who participate in high speed, high-intensity exercise. The purpose of this study was to examine the effects of two massage sessions per week for 3 weeks on hamstring flexibility. Among 10 subjects ages 18-32 (M = 4, F = 6), all participants were apparently healthy college students who were Kinesiology majors and had no history of lower limb injuries that would have impaired mobility. Hamstring flexibility was measured using an Active Straight Leg Raise protocol; measurements were made using a goniometer before and after the first, fourth, and sixth massage with a follow-up measurement 7 days after the final massage. A 5 min massage protocol using a combination of effleurage, petrissage, and friction was applied to the hamstring muscle of one leg on each subject; the opposing leg served as the control. Sessions
requiring measurements lasted less than 15 min. Statistical analysis utilized a 3 X 2 X 2 (Sessions X Tests X Legs) completely repeated measures ANOVA. The Sessions main effect was significant with improvement from Session 1 to 2, and 1 to 3 but no significant change from Session 2 to 3. The significant disordinal interaction of Tests X Legs indicated that the significant improvement in hamstring flexion of the massaged leg was due in large part to the reduced flexibility of the non-massaged leg. Paired t-tests compared the initial and final measurements for each of the legs. The results indicated a significant increase ($p < 0.05$) in hamstring flexibility in the massaged leg, but there was no significant difference in the non-massaged hamstring.

Sarah in (2010) investigated the relationship between hamstring flexibility and pelvic rotation during forward bending in healthy individuals. Hamstring flexibility has been shown to be reduced in the low back pain population, a factor which may influence the development of the condition. However, information regarding the impact of the hamstring muscles on pelvic movement during full range flexion in healthy individuals is lacking. Twenty asymptomatic subjects performed forward bending in a touch-the-toes motion; the total range was measured as the distance from the middle finger to the floor. The amount of pelvic rotation during this motion was assessed using a bubble inclinometer placed on the skin over the spinous processes of the sacrum. straight leg raise test allowed assessment of the hamstring flexibility. Hamstring flexibility strongly correlated to pelvic rotation ($R= 0.631$, $p= 0.003$) and forward bending range ($R= -0.745$, $p=0.000$). The hamstring muscles influence pelvic rotation during forward bending in healthy individuals; decreased flexibility was observed with limited rotation. Assessment of
subjects at risk of developing low back pain should include analysis of hamstring flexibility and forward bending motion.

Hall in (2001)\textsuperscript{39}, mentioned that the Mulligan traction straight leg raise (SLR) technique is used therapeutically to increase range of SLR when it is limited due to low-back dysfunction or hamstring tightness. The effects of this technique were investigated in 26 normal subjects (mean age 26 years; 13 male). As the movement of SLR comprises hip flexion and posterior pelvic rotation, ranges of SLR and posterior pelvic rotation were measured pre- and post-intervention using two bubble inclinometers. Prior to data collection, SLR was performed four times to minimize increased movement due to repetitive stretch. Following the intervention, the mean range of SLR significantly increased by 13.3° or 27%, from 49.9° to 63.2°. Mean range pelvic rotation also significantly increased but by only 2.7°. Hip flexion was the major reason for increased range of SLR following the intervention, indicating an increase in hamstring muscle stretch tolerance. The possible mechanisms for improvement in range are discussed.

Hopper in (2005)\textsuperscript{40}, investigated the effect of dynamic soft tissue mobilisation (STM) on hamstring flexibility in healthy male subjects. Forty five males volunteered to participate in a randomised, controlled single blind design study. Volunteers were randomised to either control, classic STM, or dynamic STM intervention. The control group was positioned prone for 5 min. The classic STM group received standard STM techniques performed in a neutral prone position for 5 min. The dynamic STM group received all elements of classic STM followed by distal to proximal longitudinal strokes performed during passive, active, and eccentric loading of the hamstring. Only specific areas of tissue tightness were treated during the dynamic phase. Hamstring flexibility was quantified as hip flexion angle (HFA) which was the difference
between the total range of straight leg raise and the range of pelvic rotation. Pre- and post-testing was conducted for the subjects in each group. A one-way ANCOVA followed by pairwise post-hoc comparisons was used to determine whether change in HFA differed between groups. The α level was set at 0.05. Increase in hamstring flexibility was significantly greater in the dynamic STM group than either the control or classic STM groups with mean (standard deviation) increase in degrees in the HFA measures of 4.7 (4.8), −0.04 (4.8), and 1.3 (3.8), respectively. Dynamic soft tissue mobilisation (STM) significantly increased hamstring flexibility in healthy male subjects.

2.6.2 Reviews related to reliability of the schober test

Ljubica in (2010), investigate the clinical effects of low-level laser therapy (LLLT) in patients with acute low back pain (LBP) with radiculopathy. Background Data: Acute LBP with radiculopathy is associated with pain and disability and the important pathogenic role of inflammation. LLLT has shown significant anti-inflammatory effects in many studies. Materials and Methods: A randomized, double-blind, placebo-controlled trial was performed on 546 patients. Group A (182 patients) was treated with nimesulide 200mg=day and additionally with active LLLT; group B (182 patients) was treated only with nimesulide; and group C (182 patients) was treated with nimesulide and placebo LLLT. LLLT was applied behind the involved spine segment using a stationary skin-contact method. Patients were treated 5 times weekly, for a total of 15 treatments, with the following parameters: wavelength 904 nm; frequency 5000 Hz; 100-mW average diode power; power density of 20mW=cm2 and dose of 3 J=cm2; treatment time 150 sec at whole doses of 12 J=cm2. The outcomes were pain intensity measured with a visual analog scale (VAS); lumbar movement, with Schober test; pain disability, with Oswestry disability score; and quality of life, with a 12-item short-form health survey questionnaire (SF-
12). Subjects were evaluated before and after treatment. Statistical analyses were done with SPSS 11.5. Results: Statistically significant differences were found in all outcomes measured (p<0.001), but were larger in group A than in B (p<0.0005) and C (p<0.0005). The results in group C were better than in group B (p<0.0005). Conclusions: The results of this study show better improvement in acute LBP treated with LLLT used as additional therapy.

Douglas in (2006) mentioned Lumbar spinal stenosis is a narrowing of the spinal canal or intervertebral foramen that can produce low back pain and leg pain and weakness. Surgical intervention is commonly performed to relieve these symptoms. Symptom reduction and longitudinal management of functional deficits with conservative care is less well documented. The purpose of this case series was to describe the outcomes of a conservative physical therapy program consisting of low- and high-velocity translator manipulations of T1-T9 and L1-L3, and two lumbar flexion exercises on 6 subjects diagnosed with lumbar spinal stenosis and neurogenic claudicating. A treadmill test was repeated on a weekly basis and at discharge for each patient. All six subjects demonstrated improvements in treadmill walking time prior to the onset of neurogenic claudicating (range: 1 min 34 sec to 26 min); in Oswestry Low Back Pain Disability Index scores (range: 7.5% to 64.7%); and in McGill Pain Questionnaire scores (range: 25% to 57%). Five subjects were measured using the Schober technique, and all showed improvement in thoracolumbar flexion mobility. Combined use of translatory manipulation and spinal flexion exercises may have resulted in improved spinal flexibility, ambulatory abilities, and pain and functional status in six subjects with lumbar spinal stenosis.
Figen in (2003)\textsuperscript{43}, determined the efficacy of dynamic lumbar stabilization exercises in patients with lumbar microdiscectomy. Design: A prospective, randomized, controlled study. Subjects: Forty-two patients who were diagnosed as having lumbar disc herniation and had been operated on using the microdiscectomy method were divided randomly into 3 groups. Methods: Dynamic lumbar stabilization exercises were set for the first group and a home exercise program for the second. The third group given no exercises was considered as a control group. All patients were examined twice, once before the exercise program and once 8 weeks later. Results: Improvement in the first group was highly significant after the treatment ($p < 0.0001$). The second group improved significantly more in some parameters (pain, functional disability, lumbar Schober, progressive is inertial lifting evaluation (neck), trunk endurance (flexion- extension)) than did the third group. The third group of patients showed some improvement in fingertip–floor distance, functional disability, modified lumbar Schober and left rotation in 8 weeks, but there were no significant improvements in the other parameters. Conclusion: Dynamic lumbar stabilization exercises are an efficient and useful technique in the rehabilitation of patients who have undergone micro discectomy. They relieve pain, improve functional parameters and strengthen trunk, abdominal and low back muscles.

Arja in (2003)\textsuperscript{44}, did a study associations between pain, trunk muscle strength, flexibility and disability in patients with lumbar disc herniation 2 months after surgery. Design: Clinical cross-sectional survey. Participants: 172 operated lumbar disc herniation patients. Methods: Back and leg pain on Visual Analogue Scale, Oswestry Disability Index and Brief Depression Scale were applied to assess the subjectively perceived outcome. Isometric and dynamic strength of trunk muscles and mobility of the lumbar spine were measured to mirror physical impairment. Results: Two months after the operation median leg pain had decreased by 87\% and back pain by 81\%,
respectively. However, moderate or severe leg pain was still reported by 25% and back pain by 20% of the patients. Approximately 30% of the patients perceived moderate or severe disability measured by the Oswestry index. Decreased muscle strength and spine mobility caused functional disability, especially in older patients and patients with postoperative pain. Furthermore, the ratio of trunk extension/flexion strength had changed in favor of the flexion muscles, being 0.98. Greater age and depression were associated with poorer postoperative recovery. Conclusion: Pain, decreased trunk muscle strength and decreased mobility still remained in a considerable proportion of patients with lumbar disc herniation 2 months after surgery. Early identification of those patients with restrictions is essential in order to commence rehabilitation.

Esola (2001)\textsuperscript{45}, analyzed two groups of subjects during forward bending. Group 1 (n = 20) contained subjects with a history of low back pain and Group 2 (n = 21) included subjects without a history of low back pain. The purposes of this study were to establish the amount and pattern of lumbar spine and hip motion during forward bending, and determine differences in motion in subjects with and without a history of low back pain. Reported values for lumbar spine motion during forward bending vary from 23.9 degrees to 60 degrees and hip motion during forward bending ranges from 26 degrees to 66 degrees. There has been no direct study of both lumbar spine and hip motion during forward bending in subjects with and without a history of low back pain to establish differences in total amounts or pattern of lumbar spine and hip motion during forward bending. A three-dimensional optoelectric motion analysis system was used to measure the amount and velocity of lumbar spine and hip motion during forward bending. Each subject performed three trials of forward bending that were averaged and used for statistical analysis. Hamstring flexibility was also assessed by clinical test, the straight leg raising. Mean
total forward bending for all subjects was 111 degrees: 41.6 degrees from the lumbar spine and 69.4 degrees from the hips. There were no group differences for total amounts of lumbar spine and hip motion or velocity during forward bending. The pattern of motion was described by calculating lumbar-to-hip flexion ratios for early (0-30 degrees), middle (30-60 degrees), and late (60-90 degrees) forward bending. For all subjects, mean lumbar-to-hip ratios for early, middle, and late forward bending were 1.9, 0.9, and 0.4, respectively. Therefore, the lumbar spine had a greater contribution to early forward bending, the lumbar spine and hips contributed almost equally to middle forward bending, and the hips had a greater contribution to late forward bending. A t test revealed a difference between groups for the pattern of motion. Group 1 tended to move more at their lumbar spine during early forward bending and had a significantly lower lumbar-to-hip flexion ratio during middle forward bending (P < 0.01). Hamstring flexibility was strongly correlated to motion in subjects with a history of low back pain, but not in healthy subjects. The results provide quantitative data to guide clinical assessment of forward bending motion. Results also suggest that although people with a history of low back pain have amounts of lumbar spine and hip motion during forward bending similar to those of healthy subjects, the pattern of motion is different. It may be desirable to teach patients with a history of low back pain to use more hip motion during early forward bending, and hamstring stretching may be helpful for encouraging earlier hip motion.

2.6.3 Reviews related to reliability of the Roland and Morris Disability Questionnaire as a Standard Questionnaire tools.
Deyo, et al. (1988)\textsuperscript{46} in their study, to promote and standardization measures in clinical outcomes research in patients with back pain said that; Better standardization of outcome measurement would facilitate comparison of results among studies, and more complete reporting of relevant outcomes. Because back pain is rarely fatal or completely cured, outcome assessment is complex and involves multiple dimensions. They used either the Roland or the Oswestry Disability Scale, either the SF-12 or the EuroQol measure of general health status, a question about satisfaction with symptoms, three types of "disability days," and an optional single item on overall satisfaction with medical care. They found that: A short, 6-item questionnaire and a somewhat expanded, more precise battery of questionnaires can be recommended. Although many considerations support such recommendations, more data on responsiveness and the minimally important change in scores are needed for most of the instruments.

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Underwood, Barnett, and Vickers, (1999)\textsuperscript{47} in their study to assess the Acceptability, Validity, and Reliability of two existing back pain outcome Measures, the Roland-Morris Questionnaire and the Von Korff scales, modified to measure the preceding 4 weeks. The ideal outcome measure for studies of low back pain and disability remains elusive, most existing measures assess current pain and disability shown; Measuring these factors over a preceding 4-week period may be more appropriate. Retest data suggest that these measures are repeatable. The modified Roland-Morris Questionnaire provided adequate analyzable data only if missing values were imputed, and it explained less of the variance in the comparator questions than the modified Von Korff scales. The modified Von Korff scales were completed easily and appear to be valid and repeatable in this format.
Preyde, (2000)\textsuperscript{48} in his study the effectiveness of massage therapy for low-back pain, compared two components of massage therapy and placebo in the treatment of sub acute low-back pain. He used the Roland Disability Questionnaire (RDQ), the McGill Pain Questionnaire (PPI and PRI), and the Modified Schober test (lumbar range of motion), for flexibility measurement. Statistically significant differences were noted after treatment and at follow-up.

Fritz, and Irrgang, (2001)\textsuperscript{49}, in their research to examine the validity of a global rating of change as a reflection of meaningful change in patient status and to compare the measurement properties of a modified Oswestry Low Back Pain Disability Questionnaire (OSW) and the Quebec Back Pain Disability Scale (QUE), found that; The modified OSW showed higher levels of test-retest reliability and responsiveness compared with the QUE. The minimum clinically important difference, defined as the amount of change that best distinguishes between patients who have improved and those remaining stable, was approximately 6 points for the modified OSW and approximately 15 points for the QUE. The construct validity of the global rating of change was supported by the stability of the Physical Impairment Index across the study period in patients defined as stable by the global rating and by the decrease in physical impairment across the study period in patients defined as improved by the global rating. The modified OSW demonstrated superior measurement properties compared with the QUE.

Bombardier, Hayden, and Beaton, (2001)\textsuperscript{50}, in their study "Minimal clinically important difference Low back pain" a proposed standard "core set" of outcome measures for low back pain includes 5 domains; back-specific function, generic health status, pain, work disability, and patient satisfaction. Their paper focuses on the two recommended back-specific measures of function; the Roland-Morris Disability Questionnaire (RDQ) and the Oswestry Disability Index (001). They specifically address their ability to measure change. A systematic review of the
literature identified a total of 78 and 71 (RDQ and ODI, respectively) articles as potentially relevant. Detailed tables are provided for each citation, with the type of back pain population studied, the type of change measured, the estimate of change, and the interval over which the change was studied. These tables should be used as a reference for sample size calculation. The responsiveness of the RDQ found in the literature ranges from 2 to 8 points on its 0 to 24 scale depending on what change is being measured. As a rough guide, Roland recommends that a change in 2-3 points on the RDQ should be considered the minimum clinically important change, choosing any value larger than 5 in designing a clinical trial would risk under powering the trial, since fewer patients are needed if a trial is designed on the basis of a large change score.

Kucukdeveci, Tennant, Elhan, and Niyazoglu, (2001)\textsuperscript{51}, in their research to validate the Turkish version of the RDQ for use in low back pain clinical and epidemiologic research related to low back pain in the Turkish population, where reliability was assessed using internal consistency and the interclass correlation coefficient and external construct validity was assessed by association with pain and spinal movement, mentioned that: Internal consistency of the RDQ is found to be adequate (>0.85) at both times, with high interclass correlation coefficient also at both time points. Internal construct validity of the scale is good, indicating a single underlying construct. Expected associations with pain confirm external construct validity. There is little evidence of differential item functioning. The scale is at the ordinal level. Responsiveness of the RDQ is good and greater than observed change in spinal movement The RMDQ is a robust one-dimensional ordinal measure, largely free of differential item functioning, which works well in the Turkish population. Nonparametric effect sizes of ordinal scales are found to overestimate or
underestimate the true effect size depending on the nature of the scale and the distribution of patients at baseline.

Palmieri, and Smoyak, (2002)\textsuperscript{52}, in their study manipulation under anesthesia (MUA) for patients with chronic low back pain, were used, Self-reported outcome assessment instruments to evaluate changes in patients receiving MUA versus those not receiving MUA. 87 subjects participated in this study. Selection was made from a convenience sample of patients selected from doctors who perform MUA at 2 centers participating in the study. Patients in the intervention group received MUA. Patients in the nonintervention group received traditional chiropractic treatment. A Numeric Pain Scale and the Roland-Morris Questionnaire were administered at baseline evaluation, after the procedure, and 4 weeks later. Results were documented and compared. The average Numeric Pain Scale scores in the MUA group decreased by 50\%, and the average Roland-Morris Questionnaire scores decreased by 51 \%. The average Numeric Pain Scale changes in the nonintervention group decreased by 26\%, and in the Roland-Morris Questionnaire group mean scores decreased by 38\%. In this sample of patients with chronic low back pain, self-reported outcomes improved after the procedure and at follow-up evaluation. There was more improvement reported in the intervention group than the nonintervention group. This study supports the need for large-scale studies on MUA. It also revealed that self-reported outcome assessments are easily administered and a dependable method to study MUA.

Suzukamo, et al. (2003)\textsuperscript{52} in their investigation; to validate, translate culturally, and adaptation the Roland-Morris Questionnaire, examined the reliability, validity, and responsiveness of the Japanese version of (ROQ) when assessing disability in Japanese patients with low back pain. They said ROQ is a reliable, validated scale used to measure disability caused by low back pain.
The ROQ score of the 133 patients was significantly improved after treatment. The Japanese version of the ROQ is a useful scale that is easy to use with reliability, validity, and responsiveness when assessing patients with low back pain. Sufficient reliability was demonstrated with a Chronbach's coefficient of 0.85, and the reproducibility for the 30 patients was \( r = 0.91 \). The principal component analysis showed unidimensionality.

Shaughnessy, and Caulfield, (2004), In their study "A pilot study to investigate the effect of lumbar stabilization exercise training on functional ability and quality of life in patients with chronic low back pain" mentioned that; In recent times lumbar stabilization programmed, targeting the local stabilizers in the lumbar region, have increased in popularity in the treatment of chronic low back pain (CLBP) yet their effectiveness in enhancing quality of life remains unclear. The objective of this pilot study was to examine the effectiveness of a programmed of lumbar stabilization exercises in improving quality of life and functional outcomes in patients with CLBP. The Roland Disability Questionnaire, Oswestry Disability Questionnaire and the SF-36 survey were administered to subjects in both groups at baseline and follow-up. Significant improvements were seen in all measures in the treatment group whereas control subjects demonstrated either no change or a significant worsening (\( P < 0.05 \)).

Davidson (2005), in his study, to examine fit to a Rasch model of the 24-item and two 18-item versions of the RDQ, to explore whether decisions to reject items on the basis of Rasch analysis would differ from that made by the developers of two 18-item versions of the RDQ. Differential Item Functioning (DIF) An item may attract systematically different responses on the basis of some characteristic other than item difficulty - Age -Gender - DIF by age and gender in all
versions - Item 5 Because of my back, I use a handrail to get upstairs. Traditional and Modern Test Theory approaches reject different items Rejecting items of very low/high frequency results in truncated scale RDQ can be made to fit Rasch model, but targeting is poor Gaps in item difficulty locations No items of sufficient difficulty for high ability persons.

Mousavi et al. (2006) Faculty of Rehabilitation Sciences, Department of Physical Therapy, Tehran University, IRAN, in their research "The Oswestry Disability Index, the Roland-Morris Disability Questionnaire, and the Quebec Back Pain Disability Scale; Translation and Validation Studies of the Iranian Versions", Cross-cultural translation and psychometric testing were performed. To cross-culturally translate the Oswestry Disability Index (001), Roland-Morris Disability Questionnaire (RDQ), and Quebec Back Pain Disability Scale (QDS) into Persian, and then investigate the psychometric properties of the Persian versions produced. He said to the authors' knowledge, there is no validated instrument to measure functional status in Persian-speaking patients with low back pain (LBP) in Iran. And also to our knowledge, the widely used back-specific measures, the 001, RDQ, and QDS, have not been translated and validated for Persian-speaking patients with LBP. The translation and cross-cultural adaptation of the original questionnaires were performed in accordance with published guidelines. A total of 100 patients with chronic LBP were asked to complete a questionnaire booklet (the Persian versions of the 001, RDQ, QDS, Short Form Health Survey (SF-36), and visual analog scale measure of pain). There were 31 randomly select patients with chronic LBP asked to complete the second questionnaire booklet 24 hours later. The Cronbach-alpha for the ODI, ROQ, and QOS was 0.75, 0.83, and 0.92, respectively. The ODI, RDQ, and QDS showed excellent test-retest reliability (interclass correlation coefficient = 0.91, 0.86, and 0.86, respectively) (P < 0.01). The correlation among the ODI, RDQ, QOS and physical functioning scales of the SF-36 was -0.66, -0.62, and -
0.69, respectively (P < 0.001). The correlation among the ODI, ROQ, and QOS and visual analog scale was 0.54, 0.36, and 0.46; respectively (P < 0.001). The Persian versions of the ODI, ROO, and QOS are reliable and valid instruments to measure functional status in Persian-speaking patients with LBP. They are simple and fast scales, and the use of them can be recommended in a clinical setting and future outcome studies in Iran.

As researcher mentioned before Machado, et al. (2007), in their study; compared the effectiveness of psychotherapy based on client-centered therapy, and exercise for patients with chronic nonspecific low back pain (LBP), used a 10-cm visual analog scale and the Brazilian Roland-Morris Questionnaire, respectively. The difference between groups was statistically and clinically significant for disability at 9 weeks (-4.9 points, 95% CI -9.08 to -0.72). Their results showed that client-centered therapy is less effective than exercise in reducing disability at short term.

Chou, and Huffman (2007) in their study, used Visual Analogue Pain Scale, and the Roland-Morris Disability Questionnaire.

Critchley, et al. (2007), in their study to compare the effectiveness and cost-effectiveness of three kinds of physiotherapy used the Roland Disability Questionnaire score.

There is also another rehabilitation program using Swiss ball (Marshall, and Murphy, 2006). Inversion therapy is a kind of treatment for low back pain (Vries, - and Cailliet, 1985), however some therapist used inversion table as inversion therapy for low back pain and sciatic cure, (Eidelson, 2009). Then this is important to prevention and treatment of low back pain.

Another treatment, Hydrotherapy, (2009), is the use of water to heal and ease a variety of ailments. Hydrotherapy is the most beneficial system of restoring normal functions in the body.
It is employed to help balance metabolism. Massages, (2009)\textsuperscript{62} are popular therapy used to relieve muscle tension, spasms, inflammation, fluid retention, aches, stiffness, and pain. Other benefits include improved circulation (blood and lymph), general flexibility, range of motion, and increased tissue elasticity.

**Conclusion**

There are lots of investigations that have done on low back pain. In this chapter investigator brought more than fifty researches that some of them worked on yoga and low back pain and some of them on flexibility and exercise therapy, acupuncture, manipulative exercise, physiotherapy, and physical therapy. According to Williams, (2003\textsuperscript{63}, & 2005\textsuperscript{64}), showed significant reductions in pain intensity, functional disability and pain medication usage in the yoga group. Yoga were effective for improving function and reducing low back pain, specially lyengar yoga where Kolasinki (2005)\textsuperscript{65} found out the effect of lyengar yoga on knee pain as a remedy. Woolery, (2004)\textsuperscript{66}, mentioned about low back pain related depression and mood. In agreement with Galantino, (2004)\textsuperscript{67}, and their protocol by Hata yoga where, Sherman, (2005)\textsuperscript{68}, said yoga was more effective for improving function and flexibility, and reducing low back pain. Chou (2007)\textsuperscript{69} and Huffman; showed the fair evidence that yoga is effective for chronic low back pain. They used the Ronald and Morris Disability Questionnaire.

In other hand, Van Tadler, (2000)\textsuperscript{70} et al. showed that exercise therapy was effective on patient with low back pain. Lee (1999)\textsuperscript{71} et al. and Evcik (2003)\textsuperscript{72} showed that an imbalance in trunk muscle strength and mobility might be as risk factor for low back pain. Deniz, and Aylin, (2003)\textsuperscript{73}, found that chronic low back pain abets the lower lumbar spine and limits the maximal range of lumbar extension. On this way flexibility exercise is effective on decrease low back pain.
Underwood (1999)\textsuperscript{74}, bombardier (2001)\textsuperscript{75}, found out the reliability and validity of Ronald Disability Questionnaire, Kucukdeveci (2001)\textsuperscript{76}, Suzukamo, (2003)\textsuperscript{77}, and Mosavi, (2006)\textsuperscript{78}, and Machado (2007)\textsuperscript{79} translated this Questionnaire to Turkish, Japan's, Iranian, and Brazilian, respectively. The main aim in the treatment of nonspecific low back pain is to stimulate the patient to remain or become more active in spite of the pain, in a time-contingent way. Different interventions are advised, but the main goal in most cases is to change the orientation in the patient from a pain focus to an activity focus.

**References:**


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