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An evaluation of aquatic therapy as a treatment for lower back pain

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AN EVALUATION OF AQUATIC THERAPY AS A TREATMENT FOR LOWER BACK PAIN

by

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ABSTRACT

Lower back pain (LBP) is a medical condition that will affect most of us at some point in our lives. Several medical causes have been identified for LBP, yet the large majority of LBP patients do not receive a specific diagnosis. These patients use up a large majority of health care resources, and accumulate billions of dollars in medical costs in countries throughout the globe. In recent years, an increasing focus has been placed on the idea that aquatic therapy may be an effective therapy for LBP patients. Exercise therapy has already proven itself as an effective means for treating LBP. Thus, combined with the unique properties of water, experts believe that aquatic therapy is the future of LBP treatment.

This thesis aims to explore the efficacy of aquatic therapy as a treatment for LBP. Through the analysis of controlled peer-reviewed studies, scholarly information databases, and historical data on LBP treatment, this thesis evaluates the relationship between aquatic therapy and LBP in its entirety. Scientific properties of water have shown its many uses in rehabilitative therapy treatments. Water, in theory, is able to manipulate the exercise environment to allow for more substantial progress to be made. In studies where aquatic therapy was tested versus no treatment, aquatic therapy proved to be a more efficient and effective option. Still, when placed against other therapies, aquatic therapy did not always prove more effective. While the analyzed studies support the idea that aquatic therapy is an effective treatment for LBP, further research is needed to determine how aquatic therapy holds up against other forms of treatment.

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Introduction

Lower back pain (LBP) is one of the most common and costly medical conditions in modern society. [1] Between 70-85% of people will experience LBP during the course of their lifetime. [1] Disabilities associated with LBP are among the most common impairments in the young and middle-aged populations. [1] In fact, the prevalence of LBP increases up to the age of 65, at which point it drops off. [1] Fortunately, 80-90% of LBP patients recover from this condition within a 3-month period. [2, 3] The remaining 10-20% constitute the population that suffers from LBP as a chronic condition. [1-3]

The medical problems created by LBP have a large economical impact. In 1995, LBP patients cost the United States healthcare system $8.8 billion dollars. [4] These large numbers are not unique to the United States. According to Maniadakis and Gray [5], LBP ranked as one of the most costly conditions in the United Kingdom. Other countries have shown similar rankings for LBP in their economic statistics. [5] These numbers are astounding, considering almost 50% of all LBP patients do not seek any form of medical treatment for their condition. [5]

Much debate exists regarding treatment of LBP. Exercise therapy has been proven an effective LBP treatment through many studies and peer-reviewed articles. [3, 6-8] Those with LBP should remain active otherwise prolonged disability may ensue. [9] While exercise therapy has proven to be an effective means of LBP treatment, there is still much speculation as to whether these exercise programs are more effective on land or in water. [3] This manuscript will analyze LBP as a condition, and aim to address the efficacy of aquatic therapy as a treatment for LBP.

Describing Lower Back Pain

Causes of LBP

The lower back is made up of several complex structures including vertebral ligaments, facet joints, paravertebral musculature and fascia, annulus fibrosus fibers, blood vessels, and the roots of the spinal nerves. [10] Disease or injury affecting any of these structures can lead to the patient experiencing LBP. Only 15% of LBP patients get a definitive diagnosis because linking symptoms, imaging results, and physiological changes is often difficult in these cases. [10] Yet, it is thought that the large majority of undiagnosed LBP is due to musculoskeletal degeneration or injury.[10] According to Deyo et al[10], in primary care, approximately 4% of LBP patients have compression fractures, 3% have spondylolisthesis, 0.7% have spinal malignant neoplasms, 0.3% have ankylosing spondylitis, and 0.01% have spinal infections.[10]

Who is affected by LBP

Pregnant women are a population highly affected by LBP. It is reported that between 48-56% of pregnant women report experiencing some form of back pain. [11] These pains are experienced more frequently in younger women and women who have a history of back pain pre-pregnancy.[11] Pregnant women can even experience symptoms similar to what spinal stenosis patients experience. [11]

Lower back pain is more than just a minor inconvenience for pregnant women. The pain can become so intense that it interferes with daily life. It has been reported that among Swedish

women who gave birth in 1992, approximately 7.2% went on sick leave due to back problems. [12] Physicians and therapists have been searching for ways to help pregnant women cope with the pain that comes with pregnancy. Many experts believe that aquatic therapy is the key to treating pregnancy related LBP.

Acute vs. Chronic LBP

Lower back pain patients will often be treated differently depending on whether they are experiencing *acute* or *chronic* LBP. Thus, to effectively treat LBP patients, it is important to distinguish between *acute* and *chronic* LBP. Most patients that experience LBP will fall into the acute group. [1] *Acute* back pain occurs when LBP symptoms suddenly appear after a period of 6 months minimum without any LBP symptoms. [13] Patients experiencing acute LBP will endure symptoms for a period of 3 months or less. According to Balague' and Maher, [2, 3] these patients represent 80-90% of the total LBP population and usually do not need any specific treatment for their symptoms.

The remaining 10-20% of LBP patients will develop chronic symptoms.[2, 3] *Chronic* LBP is classified as LBP symptoms that last for a duration of over 3 months.[2, 3, 13] These patients, while only a small minority of the LBP patient population, utilize most of the resources allocated to LBP patients. [13] Studies have shown that lifestyle factors, specifically sedentary lifestyles and obesity, are risk factors for developing chronic LBP. [4] Chronic LBP patients are at risk for developing various complications, such as deconditioning syndrome. [14] Patients with deconditioning syndrome experience a wide array of symptoms including decreased cardiac fitness, reduced muscular strength, impaired coordination, and decreased balance and flexibility. [14]

Properties of Water

Water has many unique properties that make for an excellent exercise medium and aquatic therapy programs may possess advantages over other forms of therapy. [7, 8, 15] This section aims to address the physical properties of water that give aquatic therapy its advantages. These properties influence the length and type of therapy that can be conducted in water, as well as the progress that can be made in aquatic therapy programs. [7, 8, 15]

Surface Tension/Drag

Water molecules align in a special way at the surface of the fluid. The molecules exhibit a strong attractive force that is in parallel alignment with the surface. This works to create a resistive force at the surface that is proportional to the object moving through it. By performing exercises at the surface of a pool, patients will experience more resistance than if they were to perform these exercises at greater depth. [7] Adjusting the resistance the patient experiences allows for variability in the training program.[6]

Buoyancy

An object immersed in water experiences an upward force called the force of buoyancy. This force is due to the displacement of the fluid in the medium. A human that is immersed in water will experience an increasing buoyant force as immersion depth is increased. This force helps to unload pressure off various parts in the body, creating a situation more conducive to rehabilitation therapy. [8] Also, by decreasing the amount of immersion, you can gradually

introduce gravitational force to help rebuild strength. [7] Ariyoshi et al, suggest that this ability to control the gravitational force makes aquatic therapy highly advantageous for LBP patients.[9]

Viscosity and Resistance Forces

Water possesses a high degree of internal resistance to objects moving through it, called *viscosity*.[8] Using water's high degree of viscosity to build strength offers unique advantages that allow for variation and patent safety.[8] The first resistance force of water is called the *accommodating force*. [15]This property of water provides a force equal to the patient's applied force thus allowing a lesser of a chance of overexertion and exacerbation. [15] Water has another force called the *variable force.* Variable force creates the ability to change the force the patient experiences during exercise. [15] This allows the patient to make gradual progress. [15]

Thermal Implications

Water has a heat capacity 1000 times greater than air and transfers heat 25 times faster. [8] These properties have a great impact on aquatic therapy programs. When a patient participates in aquatic exercise, the body is able to equilibrate to the controlled temperature of the pool due to the body having a lower heat capacity than water. Also, the patient is able to experience the thermal effects of the water much quicker than being in a temperature controlled land-based environment.[8] The temperature range of therapeutic water programs varies depending on the type of condition and therapy involved; however, aquatic therapy programs are usually conducted at temperatures ranging 33.5°–35.5°C [8]. This temperature range is optimal for the patient to experience therapeutic effects while protecting against overheating and overcooling. [8] The high

specific heat of water enables the water to stay at a roughly constant temperature throughout the entire therapy session. [8]

Aquatic Therapy as a LBP Treatment

The central aim of this thesis is to analyze the effectiveness of aquatic therapy as a treatment for LBP. An exhaustive search and collection of studies in this area was conducted to collect all pertinent data. Several studies were obtained and analyzed yielding a wide array of results. A brief overview of the studies analyzed can be seen in Table 1.

Analysis of Aquatic Therapy Studies

To effectively analyze the success of aquatic therapy as a treatment for LBP patients, an exhaustive collection of peer-reviewed scholarly studies were collected through several academic online journals. The nine studies were then placed into one of two categories: aquatic therapy as a stand-alone option or aquatic therapy versus land-based therapy. Some of the patients included in these studies are chronic LBP sufferers, recently hospitalized LBP patients, non-specific LBP patients, and pregnant women suffering from LBP. While some studies had no age requirements, it is important to note that others chose to exclude patients over 50 or 55 years old. This age exclusion could perhaps be due to the fact that LBP is more prevalent in populations under 65. [1]

Table 1- Overview of Analyzed Studies

Study	*Population examined; Primary Inclusion Criteria*	*Group Assignment Method*	*Experimental group description*	*Control group description*	*Primary outcome measures*
Sjogren, et al.[16]	60 subjects; non-specific chronic LBP; no neurological signs present in lower limbs, major trauma or spinal surgery in past 5 years, on work-related compensation.	Sequential assignment.	30 subjects; aquatic therapy program.	30 subjects; land based therapy program.	Flexion/extension tests; walking testing; VAS pain scale; Oswestry disability questionnaire.
Kihlstrand, et al.[12]	258 women; pregnant for 18 weeks; no epilepsy, over age 18, not already in aquatic therapy program.	Random assignment	129 women; aquatic therapy program.	129 women; no therapy given.	VAS pain scale, Questionnaires.
Yozbatiran, et al.[14]	30 patients; age 18-55, chronic lbp, no released disc fragments, no operations for disc herniation, no musculoskeletal disorders, no systemic ailments, no participation in a physiotherapy program within last 6 months	Random assignment	15 patients; aquatic therapy program.	15 patients; land-based therapy program.	VAS pain scale, fitness tests, anthropometry measurements, Sorensen test, Oswestry disability questionnaire.
Ariyoshi, et al.[9]	35 patients; patients chosen from hospital after adequate period of hospital treatment	All subjects assigned to experimental group.	35 patients; aquatic therapy program.	No control group.	Survey questionnaire.
McIlveen, et al.[17]	109 patients	Random assignment	56 patients; aquatic therapy program.	53 patients; No treatment given.	Lumbar flexion and extension, passive straight leg raise, tendon-reflex grading, strength grading, light-touch sensation, and

Study	*Population examined; Primary Inclusion Criteria*	*Group Assignment Method*	*Experimental group description*	*Control group description*	*Primary outcome measures*
					Oswesty disability questionnaire.
Saggini, et al.[18]	40 patients; Inclusion- suffering from chronic LBP, age < 50 years	Random assignment	20 subjects; aquatic therapy program.	20 subjects; body weight relief rehabilitation	VAS pain scale, BACKILL scale
Dundar, et al.[19]	65 patients; chronic LBP, age 20-50, no leg pain, no recent pregnancy, no serious medical illness, major rheumatologic neuroplastic, neoplastic, or other participation problems, spinal surgical history, vertebra disease, psychiatric disorder, severe cardio disease.	Sequential assignment.	32 subjects; aquatic therapy program.	33 subjects; land-based home therapy.	Spinal mobility, pain, disability, and quality of life, Oswestry disability questionnaire, Schober test, ROM testing, Short-Form 36 Health Survey.
Smith, et al.[20]	40 pregnant women; at least 19 weeks pregnant.	Self-assignment.	20 women; aquatic therapy progam.	20 women; no therapy given.	Body image, health-promoting behaviors, mobility testing, and physical discomfort. HPLP profile, Timed Get Up and Go Test, Smith's Pregnancy Discomfort Intensity Index (SPDII), Pregnancy Body Shape Questionnaire (PBSQ).
Granath, et al.[21]	390 pregnant women; must live in area of study, must be fluent in Swedish.	Random assignment	192 women; aquatic therapy program	198 women; land-based therapy program	Sick leave, pregnancy-related low back pain, pregnancy-related pelvic girdle pain

Aquatic Therapy as a Stand-Alone Treatment Option

A study conducted by Ariyoshi et al [9], chose to test aquatic therapy as a stand-alone treatment for LBP (Table 2). Thirty-five patients with LBP were chosen for this study after they had undergone adequate medical treatment in a hospital for at least 3 months. This study was especially interesting because the subjects all suffered from LBP that had been successfully diagnosed. These patients are part of the mere 15% of LBP patients that receive a diagnosis that is not "non-specific lower back pain". [10] Of the 35 patients, 18 suffered from lumbar spondylotic deformance, 5 from disc herniation, 2 from lumber spinal canal stenosis, and 10 from repeated muscular disorder.

Table 2- Group Descriptions Reported by Ariyoshi et al.[9]

Experimental group	Control Group	
Aquatic therapy program. • Static stretching of hamstrings and calves, sideways walking, front jogging, leg raises, bobbing and jumping, 25 m crawl or backstroke. • 90-minute sessions • Frequency: One session per week for 7 patients, 2 sessions per week for 19 patients, and 3+ sessions per week for 9 patients. • All patients participated in program for more than 6 months.	No control group present -	
Survey questionnaire physical scores: Mean (SD)		P-value
Patients participating 1x week	Pre-treatment: 11.4 (2.8)	Post-treatment: 10.5 (4.8)	< 0.05
Patients participating 2x week	Pre-treatment: 12.6 (4.6)	Post-treatment: 7.3 (3.7)	< 0.05

All of the 35 patients were put into an aquatic exercise therapy program for their conditions. The aquatic exercises included static stretching of the calves and hamstring muscles, 25 meter walking exercises, 25 meter jogging, 5 times leg raises, back leg raises, side leg raises, 5 times bobbing and jumping, and 25 meter swimming exercises. Each of the exercises was completed 3-4 times during each 90-minute session. There was some disparity among attendance rates in the patient population. Only seven patients participated in the program once a week, 19 patients participated twice a week, and 9 patients participated 3 times or more per week. However, all patients had been participating in the program for duration of at least 6 months when results were collected.

This study used a survey questionnaire to collect results data on the patients. The questionnaire consisted of a physical condition section, as well as a psychological condition section. The physical condition section questions pertained to degree of low back pain, condition of low back pain, trunk movement, and condition of walking. The psychological questions pertained to subjective impressions of 6 months experience in the program. The results showed that individuals who participated in the program at least 2 times per week showed significant improvement in physical scores. Concerning the psychological section, all but three subjects were satisfied or very satisfied with the program, and there were no subjects who responded negatively to the program. This study conducted by Ariyoshi et al[9], give evidence supporting aquatic therapy as an effective treatment for LBP. As for the frequency of aquatic therapy treatment programs, the results from this study suggest that it is optimal for patients to participate in therapy sessions at least 2 times per week.

McIlveen et al[17], conducted another study that tests aquatic therapy as a stand-alone treatment option (Table 3). However, their study differs from Ariyoshi et al, in that there was a control group present that did not receive any form of treatment. This study consisted of 109 patients who all contacted a large hospital seeking aquatic therapy treatment for their LBP. Patients were excluded from the study if they exhibited any of the following: uncontrolled hypertension, severe postural hypotension, left heart failure, exercise induced angina, lung vital capacity of less than $1^{1/2}$ liters, fecal or urinary incontinence, allergy to chlorine, tendency to antisocial behavior, severe limiting airway disease, and women in the first trimester of pregnancy. The 109 patients who met the requirements were randomly allocated to an aquatic therapy group (experimental), or a no therapy group (control).

Table 3 - Group Descriptions Reported by McIlveen et al.[17]

Experimental group	Control Group	
Aquatic therapy program. • 60-minute aquatic therapy sessions. • Frequency: 2 sessions per week for 4 weeks. • Led by trained pool volunteers. • Each session had 10 repetitions of 20 spinal exercises. • Makeup sessions were arranged when sessions were missed. •	No therapy given • Four-week "waiting list" for hydrotherapy.	
Oswestry Disability Questionnaire (% improvement)		P-value
Week 4: 27	Week 4: 8	0.04

The experimental group consisted of 56 patients. These patients underwent an aquatic therapy program consisting of 60-minute sessions, twice a week for 4 weeks. The remaining 53 patients were placed on a "delayed hydrotherapy list". Patients in this group were essentially

told they would receive aquatic therapy after a 4-week waiting period, thus making them a control group receiving no form of therapy. The aquatic therapy treatment sessions consisted of 10 repetitions of 20 different spinal exercises. Unlike the study conducted by Ariyoshi et al[9], patients were required to make up any sessions they may have missed.

Measurements were taken regarding lumbar flexion and extension, passive straight leg raise, tendon-reflex grading, strength grading, light-touch sensation, and disability as described by the Oswestry Disability Index (ODI). The results showed that differences between the two groups were insignificant for all measurements except the Oswestry Disability Index. In the experimental group, 27% of patients showed improvement in ODI functioning, as opposed to only 8% of patients in the control group. As a result, the Oswestry Disability Index was the only measurement showing the statistical advantage of aquatic therapy over no therapy for LBP in this study. Still, McIlveen et al[17] did note that although the results from the other measurements were not statistically significant, the patients who improved were typically in the experimental group. This study suggests that aquatic therapy is a more effective than no treatment in improving patient functioning as described by the Oswestry Disability Index.

The next study conducted by Kihlstrand et al[12], chose to test a specific group of subjects from the LBP population (Table 4). They aimed to test whether aquatic therapy was an effective way to reduce the intensity of LBP in the pregnant population. This is an extremely relevant population to test because more than one-third of pregnant women will experience LBP during their pregnancy. [21]

Table 4 - Group Descriptions Reported by Kihlstrand et al.[12]

Experimental group	Control Group	
Aquatic therapy program. • Exercises recommended by the Swedish Swimming Society and tested for pregnant women. • One-hour sessions; 30 minutes physical therapy, 30 minutes relaxation. • All sessions led by a specially trained midwife • First ten sessions were specific to early pregnancy; last 10 were suited for later pregnancy.	No therapy given -	
Frequency: One therapy session per week for 20 weeks.		
Women on sick leave due to LBP (n)		P-value
After week 32-33: 7	After week 32-33: 17	0.031

This study chose a population of 258 pregnant women who had been pregnant for more than 18 weeks. Subjects were excluded from the study if they suffered from epilepsy, were under the age of 18, or were already enrolled in an aquatic therapy program. The 258 women that met the study criteria were then randomly assigned to either the experimental or control group. The experimental group was offered aquatic therapy once per week until they gave birth, while the control group was offered no therapy at all. The primary outcome measure of the study was the number of women on sick leave due to LBP. In the aquatic therapy group, 12.9% of women were on sick leave due to LBP at some point during the study. The control group nearly doubled this statistic with 21.7% of women taking sick leave during the course of the study. After week 32-33, the control group had 17 women on sick leave, while the aquatic therapy group had only seven.

The researchers also used VAS pain scales in questionnaires to assess the intensity of LBP experienced by the patients at week 18, 34, and the first post partum week. This study showed some interesting results due to the measurements being recorded 3 times during the second half of pregnancy. During week 18 there was no difference in LBP intensity between the two groups. However, after this checkpoint, women in the aquatic therapy group reported having less intense LBP for the remainder of the study. The difference between the two groups became statistically significant in the first post partum week. Kihlstrand et al[12], note that the overall intensity of LBP increased as the study progressed. Perhaps, as the intensity of LBP increases, aquatic therapy becomes more effective than no therapy. In any case, the results from this study support the idea that aquatic therapy can be an effective means of reducing LBP intensity and number of sick leave days due to LBP in the pregnant population.

Smith et al[20], also chose to test aquatic therapy as a means for treating LBP in the pregnant population. However, this research study differs from the study conducted by Kihlstrand et al in a number of ways. First, the sample population consisted of 40 pregnant women instead of 258 pregnant women. This smaller sample size of this study raises questions about the real differences between the experimental and control groups. Second, the subjects were allowed to self-assign to either the experimental or control group rather than being randomly assigned. This could lead to increased bias in the group selection process. Also, the subject population was 75% obese and 60% African American. These two factors could easily have affected the efficiency of aquatic therapy to treat LBP during the course of the study.

Table 5 - Group Descriptions Reported by Smith et al.[20]

Experimental group	*Control Group*	
Aquatic therapy program. • First 10 minutes warm-up and stretching. • Continual movement phase for 25-30 minutes. ○ Targeted large muscles like legs and buttocks. • Last phase designed to strengthen abdominal muscles, stretch lower back, and increase flexibility. • Each session ended with a warm-down, stretch-out, and relaxation session.	No therapy given -	
Smith's Pregnancy Discomfort Index: Mean (SD)		P-value
Pre-treatment: 3.5 (1.9)	Pre-treatment: 2.8 (1.9)	Not reported
Post-treatment: 2.7 (1.3)	Post-treatment: 4.9(1.4)	Not reported

The experimental group consisted of 20 pregnant women enrolled in an aquatic therapy program. The aquatic therapy program was offered to the women 3 times per week for a period of 6 weeks. During this 6-week period, the women in the control group received no form of therapy.

Measurements were taken regarding body image, health-promoting behaviors, mobility testing, and physical discomfort. The physical discomfort section assessed the prevalence of LBP using Smith's Pregnancy Discomfort Intensity Index (SPDII). The results in this area showed that aquatic therapy positively impacted maternal discomforts including LBP associated with pregnancy more than no therapy. While this research study did not use the best methods

available to ensure the elimination of bias, it still produced results supporting the idea that aquatic therapy positively impacts LBP in pregnant populations.

Aquatic Therapy Versus Land-Based Therapy

For years, experts have agreed that exercise therapy is effective for the treatment of LBP. Yet, they have not come to a consensus on which type of exercise therapy is better, land-based therapy or aquatic therapy. [3] The studies addressed in this section, collected data aimed at finding an answer. To do this they chose to make their experimental group undergo an aquatic therapy program, while their control group underwent a land-based therapy program. Knowing the theoretical advantages of aquatic therapy programs, many researchers entered into these studies expecting to see better results coming from the experimental groups. Yet, not all studies found this to be true.

The first study conducted by Sjogren et al[16], chose to use a subject population of 60 patients (Table 5). Patients were included in the study if they met the following criteria: suffering from non-specific LBP for at least 6 months, no neurological signs present in the lower limbs, no major trauma or spinal surgical history in past 5 years, not on work related compensation, have a basic understanding of written and spoken English, and showed no signs of contraindications to hydrotherapy. All of the patients meeting the inclusion/exclusion criteria were then sequentially assigned to either the experimental or control group. This method was chosen over the traditional random assignment in order to minimize the delay in the commencement of each patient's treatment.

Table 6 - Group Descriptions Reported by Sjogren et al.[16]

Experimental group	Control Group	
Aquatic therapy program. • Aquatic exercises aimed at increasing truncal range of movement and general strength and endurance. • 50-minute sessions with 5 minutes of warm up and cool down.	Land-based therapy program. • Land-based exercises aimed at increasing truncal range of movement and general strength and endurance. • 50-minute sessions with 5 minutes of warm up and cool down.	
Frequency: 2 group sessions per week for a period of 6 weeks.		
VAS Pain Scale		P-Value
Baseline (A1): 4.97 (2.88)	Baseline (A1): 4.77 (2.47)	A1→A2: .6364
Pre-treatment (A2): 5.53 (3.12)	Pre-treatment (A2): 5.02 (2.99)	A2→A3: .7565
Post-treatment: (A3): 4.18 (3.15)	Post-treatment: (A3) 4.23 (2.74)	

The experimental group consisted of 30 patients participating in an aquatic therapy program. This program consisted of two 50-minute group aquatic therapy sessions per week for duration of 6 weeks. The thirty patients in the control group underwent a land-based therapy program. This program also consisted of two 50-minute group therapy sessions per week for duration of 6 weeks; however, the sessions were conducted on land rather than in water.

Measurements were taken in the form of flexion/extension tests, walking testing, VAS pain scale, and the Oswestry disability questionnaire. The results showed that both the experimental and control group showed a drop in pain levels, yet the difference between the two groups was not significant. Patients in both groups were able to walk farther, yet there was no significant difference between the two groups. Oswestry scores showed that patients in both groups showed significant increase in functional ability, yet again there was no significant

difference between the two groups. This study provides substantial data supporting *both* aquatic therapy and land-based therapy as effective treatments for LBP. These results are very encouraging for exercise therapy treatments for LBP. Still, the data was unsuccessful in showing that the exercise medium, land or water, had any effect on the patient results.

A study conducted by Yozbatiran et al[14], also chose to see if exercise medium had any substantial effect on treatment efficacy (Table 6). The study population consisted of 30 chronic LBP patients who were referred for physical therapy by the same hospital neurosurgery department. Subjects had to be between the ages of 18-55, suffering from chronic LBP, have no released disc fragments, no operations for disc herniation, and participate in the study voluntarily. They were excluded from the study if they exhibited any musculoskeletal disorders, systemic ailments, or had participated in any physical therapy program within the previous 6 months. Subjects meeting the defined criteria were then allocated to the experimental or control group.

Table 7 - Group Descriptions Reported by Yozbatiran et al.[14]

Experimental group	Control Group		
Aquatic therapy program. • Same program as land-based therapy program but performed in a pool.	Land-based therapy program. • Warm-up and stretching • 15 progressive exercises. • Cool down and stretching with light aerobic exercise.		
Frequency: Therapy sessions 3 days per week for 4 weeks.			
VAS Pain Scale: Mean (SD)			P-value
Experimental group	Pre-treatment: 5.46 (2.19)	Post-treatment: 1.93 (1.70)	0.002
Control group	Pre-treatment: 5.06 (2.28)	Post-treatment: 2.53 (1.55)	0.002

The experimental group consisted of 15 patients enrolled in an aquatic therapy program. This program consisted of 12 physiotherapy sessions during 4 weeks performed in water. The control group also consisted of 15 patients undergoing physiotherapy sessions for 4 weeks performed on land. Measurements were taken using the VAS pain scale, aerobic fitness testing, musculoskeletal fitness testing, motor fitness testing, anthropometry measurements, Sorensen isometric trunk testing, and the Oswestry disability index questionnaire.

Like the study conducted by Sjogren et al[16], the results failed to produce any significant differences between the treatment groups. Both groups showed increased walking distances, lower pain levels, increased dynamic sit-up counts, increased spinal flexibility, significant improvement in isometric trunk exercises, and a slight body fat distribution decrease. Once again, these results yield data supporting aquatic therapy *and* land-based therapy as effective

treatments for LBP patients. Yet, the significantly small sample size in this study could have posed some difficulties to seeing differences between the groups.

The last two studies failed to show any difference in results between aquatic therapy and land-based therapy. However, a study conducted by Dundar et al[19], produced results that suggest one form of therapy is indeed more effective than the other at treating LBP (Table 7). The study consisted of 65 patients suffering from chronic LBP. The patients had to be between the ages of 20-50, suffering from LBP without leg pain for over 3 months, not been recently or currently pregnant, have no other serious medical illness or symptoms, have no major participation problems, no spinal surgical history, no vertebra disease, no psychiatric disorder, and no known cardiovascular disease. The 65 patients that met the inclusion/exclusion criteria were sequentially assigned to either the experimental or control group.

The experimental group consisted of 32 subjects participating in an aquatic therapy program. This program consisted of sessions 5 times per week for 4 weeks in a swimming pool at 33°C. The control group in this study differed significantly from the land-based therapy programs seen other studies. A physiotherapist conducted the first session of the land-based therapy program; however, the patients then received notes and instructions on how to continue their therapy at home. To ensure that patients were keeping up with their home-based program, telephone check-ins were made weekly during the entire program.

Table 8 - Group Descriptions Reported by Dundar et al.[19]

Experimental group	Control Group
Aquatic therapy program. • 60-minute group sessions of 7-8 patients. • 15 minutes of warmup, range of motion, and relaxation. • 40 minutes of aquatic exercises including walking, jogging, jumping, fast running in place, stretching, and strengthening exercises • 5 minutes of cool-down exercises.	Land-based therapy program. • Demonstrated by a physiotherapist, then performed independently at home. • 60-minute program. • Exercises included: flexion, extension, mobilization, stretching, strengthening, relaxation, aerobic fitness, and cooling down exercises. • Each exercise performed once a day with 15-20 repetitions. • Telephone follow-ups were done weekly.

Frequency: Therapy sessions 5 times per week for 4 weeks.

VAS Pain Scale: Mean (SD)

Experimental Group				
	Week 0	Week 4	Week 12	P-value
Pain at movement	7.23 (1.66)	3.56 (1.05)	3.11 (1.24)	< 0.001
Pain at rest	4.72 (2.05)	1.68 (1.12)	1.46 (1.21)	< 0.001
Pain at night	4.75 (2.70)	1.71 (1.30)	1.51 (1.40)	< 0.001
Control Group				
	Week 0	Week 4	Week 12	P-value
Pain at movement	7.21 (1.56)	3.82 (1.17)	3.33 (1.20)	< 0.001
Pain at rest	4.82 (2.40)	1.90 (1.33)	1.71 (1.52)	< 0.001
Pain at night	4.68 (2.40)	1.93 (1.60)	1.75 (1.40)	< 0.001

Unlike the other studies addressed in this thesis, Dundar et al[19] chose to measure the patient's pain at rest, at night, and at movement. The subjects were able to describe their pain to researchers by the means of a VAS scale for pain. Patients were also analyzed using the modified Schober test for spinal mobility, range of motion testing for overall mobility, the Oswestry disability questionnaire for disability, and the SF-36 Health Survey for quality of life. The results of the study showed that both groups had a significant improvement in all parameters except the modified Schober test. However, the aquatic therapy group showed better improvements in the Oswestry disability questionnaire, as well as the physical functioning and role limitations due to physical functioning subpart of the SF-36. This better improvement in the experimental group could very well be due to the low supervision level of the independent land-based therapy program. However, the data from this study supports the idea that aquatic therapy is more effective in reducing disability and increasing physical components of quality of life than an independent land-based therapy program.

A study conducted by Saggini et al[18], chose to examine the efficacy of aquatic therapy as well as land-based body weight relief rehabilitation therapy as treatments for LBP patients (Table 8). What is unique about this study is the use of body weight relief instruments in the control group program. Also, this study chose to monitor not only short-term results at the end of the study, but also long-term results at 1-year post treatment.

The subject population consisted of 40 consecutive LBP patients under the age of 50. Patients were excluded from the study if they did not meet the following inclusion criteria: primary LBP for at least 12 months, increase in pain beginning at least 4 months before, MRI

confirmed disc herniation or protrusion, and assurance of cooperation with study requirements. The patients who met the inclusion requirements were then randomly assigned to the experimental or control group.

Table 9 - Group Descriptions Reported by Saggini et al.[18]

Experimental group	Control Group	

Aquatic therapy program.
• First phase:
  ○ Main goal- pain reduction, correction of postural defects and the re-establishment of normal motion patterns.
• Intermediate phase:
  ○ Main goal- increase pain-free range of movement, pain-free activities, and increase torque from trunk muscles.
• Last phase:
  ○ Started when the range of motion of patient was pain-free..
	Body weight relief rehabilitation therapy
	• Therapy program conducted on land
	• Consisted of special physical therapy exercises with body weight relief assistance, as well as exercises without body weight relief.	

Frequency: Therapy sessions 3 days per week for 7 weeks.		
VAS Pain Scale: Mean (SD)		P-value
Pre-treatment: 8.1 (5-10)	Pre-treatment: 8.2 (5-10)	Not significant.
Post--treatment: After treatment there was a significant improvement in VAS scores. After one year, VAS scores were significantly different from after treatment values.	Post-treatment: After treatment there was a significant improvement in VAS scores. After one year, scores did not show any significant change from after treatment values.	< 0.01

The experimental group consisted of 20 patients enrolled in an aquatic therapy program 3 times a week for 7 weeks. The aquatic exercises were divided into 3 phases with specific goals.

First, exercises were focused on pain reduction, correction of postural defects, and re-establishment of normal motion patterns. Next, the second phase focused on increasing pain-free range of motion (ROM), increasing the capacity of trunk muscles to generate torque, and increasing the number of activities that can be performed without pain. Finally, the last phase was initiated when ROM of the patient was completely pain-free. This phase focused on dynamic control for posture and muscular endurance, and included exercises such as twisting, lateral bending, and flexing-extending exercises for the hip joint. The control group consisted of 20 patients enrolled in a land-based body relief rehabilitation therapy program. This program consisted of exercises performed with equipment that helped reduce the body weight experienced by the patient during the exercise, as well as exercises performed with no mechanical assistance. Like the experimental group, this program was given to patients 3 times a week for 7 weeks.

Measurements were taken using a VAS scale to measure pain, as well as the Backill scale for assessing spinal column function. The subjects were analyzed using these two methods when treatment ended, as well as 1-year post treatment. Initially following treatment, both groups showed a significant improvement in both VAS and Backill values. However, after 1 year the control group scores were unchanged from the scores initially following treatment, whereas the experimental group scores were significantly different from the scores initially following treatment. Aquatic therapy was proven to be an effective treatment for reducing LBP pain and increasing LBP patient functionality in the short term. However, in the long term, land-based body weight rehabilitation therapy was proven to be more effective at treating pain and disability due to LBP.

Previous studies addressing the pregnant LBP populations chose to test aquatic therapy against a control group receiving no therapy. However, a study conducted by Granath et al[21], aimed to see if aquatic therapy was more effective than land-based therapy when treating LBP in the pregnant population. The subject population was made up of 390 pregnant women. Women were excluded from the study if they did not meet the following criteria: voluntary participation, fluency in Swedish, and local residence in study area. The subjects meeting the inclusion criteria were randomly assigned to either the experimental or control group. Of the original 390 included subjects, only 134 received the experimental therapy and 132 received the control therapy. Thus, 134 subjects in the experimental group and 132 subjects in the control group were analyzed at the end of the study for results.

Table 10 - Group Descriptions Reported by Granath et al.[21]

Experimental group	Control Group	
Aquatic therapy program. • 45 minutes of activity followed by 15 minutes of relaxation. • Set of aquatic exercises developed by midwives and physiotherapists for pregnant women.	Land-based therapy program. • 45 minutes of activity followed by 15 minutes of relaxation. • Set of exercises developed by physiotherapists for fitness during pregnancy. • Focused on improving aerobic fitness and mobility.	
Frequency: 1 session per week for duration a pregnancy.		
Women Experiencing Pregnancy-Related Low Back Pain (%)		P-value
Baseline: not reported.	Baseline: not reported	Not reported
Post-treatment: 19	Post-treatment: 34	0.04

The experimental group was enrolled in an aquatic therapy program that took place once a week until they gave birth. The program consisted of 45 minutes of aquatic exercises followed by 15 minutes of relaxation. Midwives and physiotherapists developed the exercises especially for pregnant women. Specially trained midwives led each aquatic therapy session. The control group performed a program of similar duration with exercises designed by physiotherapists for fitness during pregnancy. Experienced aerobic instructors instead of midwives led these sessions.

Measurements were obtained during each of the subjects scheduled pregnancy checkups. If a women experienced pain during one of these checkups, they were examined and their pain was classified as pregnancy-related pelvic girdle pain (PPP) or pregnancy-related low back pain (PLBP). The results showed that women in the aquatic therapy group experienced less LBP during pregnancy and took fewer sick leaves than women in the land-based therapy group. The results of this study suggest that aquatic therapy is more efficient at treating pregnancy-related LBP than land-based therapy. As Granath et al[21] point out in their study; this may indicate that land-based therapy is no more beneficial for treating PLBP than no exercise at all.

Discussion

Patients with LBP are presented with many different treatment options ranging from laser therapy to aquatic therapy training programs. [3] The unique properties of water have sparked an intense interest in aquatic therapy treatment programs. Through analysis of peer-reviewed studies, this thesis aimed to analyze the efficacy of aquatic therapy as a treatment for LBP patients.

The analysis of these studies offers support for aquatic therapy as a treatment for LBP. Aquatic therapy was proven to be more effective than no therapy in the following areas: reducing LBP in general, reducing LBP in the pregnant LBP population, reducing sick leave in the pregnant LBP population, and increasing functional ability as described by the Oswestry Disability Index. Thus there is substantial evidence supporting the idea that a LBP patient would benefit more from enrolling in an aquatic therapy program then receiving no treatment at all.

While aquatic therapy was shown to be more effective than no therapy, there is still some debate as to whether it is in fact more efficient than land-based therapy in treating LBP patients. In studies conducted by Sjogren et al[16] and Yozbatiran et al[14], there was no significant difference between aquatic therapy and land-based therapy in the following areas: functional ability as described by the Oswestry Disability Index, spinal flexibility, walking distances, VAS pain scores, anthropometry measurements, Sorensen test scores, and flexion/extension tests. Aquatic therapy was even shown to be less effective than land-based therapy that used body weight relief tools in its program. This study, conducted by Saggini et al[18], showed that initially the two forms

of therapy yielded the same results; however, land-based body weight relief rehabilitation therapy was more effective than aquatic therapy in producing long lasting results.

Still, there is some evidence supporting the idea that aquatic therapy is more effective than land-based therapy in treating LBP patients. The study conducted by Dundar et al[19], showed that aquatic therapy was more effective than an independent land-based therapy program in increasing patient functionality and quality of life for LBP patients. While this data is encouraging, the fact that the land-based therapy program was unsupervised adds confounding factors. Future studies should have the same level of program supervision in both groups to yield better results. Granath et al[21], did provide us with some results supporting aquatic therapy over land-based therapy. They found that aquatic therapy was more effective in reducing pregnancy-related LBP and sick leave due to pregnancy-related LBP than land-based therapy. This data was in agreement with the belief of midwives that aquatic therapy reduces LBP and allows women to work later into their pregnancy.[12] In addition, Kihlstrand et al[12], noted that aquatic therapy was greatly appreciated by the pregnant women.

Conclusion

The belief that aquatic therapy is an effective treatment for LBP patients was supported. Aquatic therapy was proven to be more effective than no therapy in all studies analyzed. However, the results did not show that aquatic therapy is more efficient than land-based therapy in treating LBP. Advocates of exercise therapy should find the results of this thesis encouraging. Exercise therapy, regardless of medium, was proven to be an effective treatment for LBP in all studies addressed. However, further research is needed to test the efficacy of aquatic therapy against other LBP treatment options.

Key Points

- The idea that aquatic therapy is an effective treatment for LBP was supported.
- Aquatic therapy is more effective than no therapy for treating LBP.
- Aquatic therapy was not shown to be more effective than land-based therapy in treating LBP.

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