International Journal of Aquatic Research and Education

Volume 4 | Number 4 Article 9

11-1-2010

2010 International Aquatic Therapy Symposium Proceedings

Aquatic Therapy & Rehab Institute, Inc.

2010 INTERNATIONAL AQUATIC THERAPY SYMPOSIUM

International Journal of Aquatic Research and Education, 2010, 4, 432-452

Poster Presentation Abstracts

Supporting Aquatic Therapy: Where Do I begin?

Janet MK Gangaway, PT, DPT, OCS, ATC, ATRIC

Traditionally, aquatic therapy providers use treatment techniques that appear to work from an anecdotal or historical perspective. Many of these early techniques continue to be used today with little evidence to support their effectiveness. There is a valid need to support intervention techniques with scientific literature, commonly known as evidence -based medicine (EBM). EBM is the integration of research evidence with clinical experience and incorporating patient/client values. The first step to locating the research evidence is to ask good questions such as who is the client/population of interest, what intervention is to be used, what outcome is expected, and how does that intervention compare to other treatments. Once evidence is located it should be critically appraised to determine its value/applicability to your patient/client.

SykorovaSynchro Method

Dr. Maria Sykorova-Pritz, EdD

Our overall health/ wellbeing result from interactions among genetic, biochemical, environmental and psychosocial factors, which may play a role in learned adaptive responses. This type of response can be unlearned and what was forgotten can be remembered. It is important to educate clients of any age to influence, maintain and improve their physical, emotional and learning abilities (i.e., experience your body the way it is meant to be). With improvement of sensory motor learning abilities, one can develop skills and knowledge not to fight, but rather meet the challenges of life without fear and uncertainty.

The SykorovaSynchro Method teaches more about land/ water-based somatic exercises as a teaching method. It demonstrates how to incorporate and achieve positive changes in life by providing a new sense of self awareness and control, stress reduction, revitalization of energy flow, postural alignment and flexibility, circulation, sensory-motor learning ability and creativity.

SykorovaSynchro is a therapeutic body & mind balancing educational method of integrating techniques.

Robert Chetlin, Steven Wheeler, Shelby Crane, and Sheryl Morris are with the Human Performance Department and Lori Sherlock is with Exercise Physiology, all with West Virginia University in Morgantown

SykorovaSynchro Method focuses on achieving physical symmetry, between muscular and skeletal structures. It also focuses on mind & body symmetry by using targeted movements to trigger valuable information flow between the muscles and the brain. The focus of this is to improve function while reducing muscular effort to perform basic needs and live a healthy lifestyle.

This method will help to identify which muscles / movements experience discomfort and teach the most efficient way to relieve excess tension.

An exercise program based on the "SykorovaSynchro Method" incorporates somatic exercises, in which "self – sensing "is essential. This internalized perception /body awareness is a skill that allows a person to accurately assess what they are experiencing somatically to answer the question, "What is happening to my body?"

Somatic exercises are highly valued for their contribution to successful pain management and the recovery process. Conscious control over learned habits is taught to improve posture for the relief of pain.

An aquatic/ land based exercise program based on the SykorovaSynchro Method will help to stabilize and harmonize emotional, social, physiological, spiritual and intellectual aspects of health. This is all accomplished by applying the neurological rule that "the less muscular effort used, the more enhanced sensory awareness becomes for learning and physical performance."

Research Forum – Reports

Comparative Study of the Effects of Aquatic Versus Land-Based Lumbar Stabilization Exercises and Improving Function in Patients With Unstable Spine

Jason Adames, DPT and Robert Bayley, DPT, Wheeling Jesuit University, Department of Physical Therapy, Wheeling, West Virginia

This investigation reports two participants' response to either a land-based lumbar stabilization program or the Aquatic Lumbopelvic Stabilization Protocol in regards to pre and post pain ratings, objective measures and functional findings using the Oswestry Disability Index. The research consisted of a convenience sample case study of two participants. Participant #1 was a 45 year old female with a diagnosis of chronic low back pain and fibromyalgia, limiting her ability to sleep, to perform household chores, and to participate in family activities. Participant #2 was a 48 year old female with a diagnosis of chronic low back pain, limiting her ability to perform a home exercise program, sit for prolonged periods, and perform job related functions. In this case study, the method consisted of a physical therapy evaluation, involving measurements in AROM, strength, flexibility, joint biomechanics, joint mobility, special tests for lumbar spine instability, and the Oswestry Disability Index Questionnaire. Patient #1 was placed into the land based lumbar stabilization program and patient #2 was placed into the Aquatic Lumbopelvic Stabilization Protocol.

Results

The objective results for Patient #1, prior to the completion of the land based lumbar stabilization protocol, include the following:

- Posture: Patient presents with the following in standing: forward head with protruding C7; bilateral internally rotated shoulders with protracted scapulae; increased thoracic curve; increased lumbar curve; left lumbar scoliosis; bilateral externally rotated hips; bilateral genu recurvatum; bilateral midfoot pronation. In sitting, patient presents with forward head; bilateral elevated and internally rotated shoulders; and tends to sacral sit.
- Gait: decreased cadence; right heel whip; bilateral externally rotated lower extremities noted during stance phase; increased step widths bilateral lower extremities; lateral shift with right heel strike; and decreased toe-off propulsion in bilateral lower extremities.
- Range of Motion: Lumbar spine: Flexion = 45 degrees with increased pain; side bending left = 55 degrees; side bending right = 45 degrees with complaints of difficulty with the movement; rotation right = 30 degrees of pain free movement; rotation left = 25 degrees; extension = 12 degrees with pain noted throughout motion. Bilateral lower extremities are within normal limits grossly.
- Strength: Trunk: Abdominals = 3 +/5 with decreased muscle endurance noted; extensors not tested due to increased pain complaints. Right lower extremity = 4-/5 except for hip adduction = 4+/5, hip internal rotation = 3+/5, extensor hallicus longus = 3+/5. Left lower extremity = 4/5 throughout except for internal/external hip rotation = 4-/5, and extensor hallicus longus = 3+/5.
- Flexibility: Restriction include: bilateral pectoralis complex; bilateral quadriceps; and bilateral gastroc/soleus complex.
- Special tests: (+) right straight leg raise; (+) kernig; (+) right dural stretch; (+) right femoral neural tension test; (+) right FABER; (+) Aberrant Movement Test (1,2,4,5); (+) Segmental Instability Test.
- Biomechanics: patient unable to maintain lumbopelvic neutral in supine with minimal challenges. In addition, decreased and latent activation noted for bilateral transverse adominus and right multifidus.
- Joint mobility: Hypomobile noted for L2-3, L3-4, and L4-5 when assessed with posterior/anterior glides.
- Balance: Inconsistent balance noted for right unilateral stance position
- Palpation: Patient complains of pain with palpation of right sacroiliac joint; right piriformis musculature; and the right sacrotuberous ligament. In addition, hypertonicity noted in the right lumbar extensors.

The objective results upon discharge from the land-based lumbar stabilization program are as follows:

- Posture: In standing, posture remains as per Initial Evaluation except for bilateral shoulders/scapulae are neutral and bilateral lower extremities are neutral.
- Range of Motion: Trunk: Flexion = 90 degrees; extension = 20 degrees with end range pain noted; rotation left/right = 45 degrees; and side bending left/right = 55/50 degrees respectively.
- Strength: Trunk: abdominals = 4/5; extensors = 4/5; and bilateral lower extremities = 4/5 grossly.
- Flexibility: Restrictions noted for pectoralis complex bilaterally and bilateral quadriceps musculature.
- Biomechanics: Patient able to maintain lumbopelvic neutral with moderate challenges in various positions, and can self-correct when she deviates from neutral. While latent activation noted for transverse abdominus (possibly due to multiple abdominal surgical interventions), patient able to activate multifidi as needed.
- Palpation: Patient continues to note pain with palpation of right sacroiliac joint and muscle hypertonicity persist for bilateral lumbar extensors.

The subjective results for patient #1 upon discharge include the patient report that she continued to experience low back pain but that she was able to perform all household tasks, whereas in the past, she frequently went to bed when the low back pain intensified. In addition, patient noted that she was walking 2-3×/week for ½ to ¾ mile at night for exercise; in the past she would not have considered this an option. Patient did recognize that she would need to continue with her home exercise program, but stated that she was encouraged that she could now do “things” such as shopping, family activities, etc. without considering where/when she could lie down to alleviate her pain. Upon discharge, the PT stated that patient #1 had, predominantly, achieved her physical therapy goals and no additional treatment was warranted at that time.

The objective results for patient #2, prior to the completion of the Aquatic Lumbopelvic Stabilization Protocol, included the following:

- Posture: In standing patient presents with forward head; decreased thoracic curve; symmetrical iliac crests; bilateral genu valgus; right rear foot valgus; and bilateral pes cavus.
- Gait: cadence is increased; increased although symmetrical pelvic excursion; increased/early supination at left heel strike; decreased step widths noted bilaterally; increased speed generated by increasing steps per minute versus increasing step-lengths.
- Active Range of Motion: Trunk: Flexion = 105 degrees; extension = 35 degrees; rotation right/left = 60/45 degrees respectively; side bending right/left = 35 degrees; and bilaterally lower extremities within normal limits grossly.
- Strength: Trunk: abdominals = 4-/5; extensors = 4/5; and bilateral lower extremities are 4+ to 5/5 throughout.
- Flexibility: Restrictions noted for bilateral latissimus dorsi musculature; bilateral quadriceps, and bilateral hip external rotators.

- Joint Mobility: Mid-thoracic through lumbar spine is normal when assessed with posterior/anterior glides except for L2-4. In addition, L5-S1 is hypermobile.
- Biomechanics: Patient was able to maintain lumbopelvic neutral with minimal challenges in supine and sitting, but moderate challenges in any position elicit anterior pelvic tilt. In addition, patient activated transverse abdominals late, and appeared to do better when tactilely cued.
- Special tests: (+) Segmental Instability, (+) Aberrant Motion Test for painful arc, painful arc in return, and instability catch; (-) for the following performed on left/right: SLR, FABER, OBER, dural stretch. In addition (-) for Gilet and kernig.
- Palpation: Patient complained of pain with palpation for L2-5 spinous processes and adjacent lumbar extensors, left side more than the right.

The objective results for patient #2 upon discharge of the ALSP are as follows:

- Active Range of Motion: Trunk: As per Initial Evaluation except for left trunk rotation = 55 degrees.
- Strength: Trunk: abdominals and extensors = 4+/5.
- Flexibility: bilateral latissimus dorsi are normal; and lower extremity restriction, while subjectively noted are improved, remain as per Initial Evaluation.
- Biomechanics: Patient was able to maintain lumbopelvic neutral with moderate challenges in various positions, and can maintain with moderate + challenges in supine and sitting.

The subjective results for patient #2 upon discharge from the aquatics based lumbar stabilization program included the patient reports that she is able to manage her low back pain, although she continued to note occasional discomfort with prolonged sitting. In addition, patient stated that she believed she could activate her core muscles to support her appropriately when she was forced to stand or sit without moving. Upon discharge the PT stated that patient #2 had predominantly achieved her physical therapy goals and no additional treatment was warranted at this time.

The Oswestry Disability Index results for patient #1 included a pre-treatment score upon evaluation of 28% (moderate disability level) and a post-treatment score upon discharge of 4% (minimal disability level). This was a reduction of 24% of perceived disability, along with a reduction in one disability, secondary to a decrease in perceived pain and a subjective increase in function. The Oswestry Disability Index results for patient #2 included a pre-treatment score upon evaluation of 52% (severe disability level) and a post-treatment score upon discharge of 20% (minimal disability level). This was a reduction of 32% perceived disability, along with a reduction in two disability levels, secondary to a decrease in perceived pain and a subjective increase in function.

The results for patient #1 show improvements in lumbar spine AROM, core muscle strength, and joint biomechanics, but remain unchanged in flexibility, joint mobility and spinal instability special testing. Patient #1's Oswestry results were 26% prior to the program and 4% after the completion of the program. The results for Patient #2 showed improvements in lumbar spine AROM, core muscle strength, joint biomechanics, flexibility, joint mobility, and all instability special tests were negative. The Oswestry results were 52% prior to the protocol and 20% after completion of the protocol.

In this research, conclusions could be drawn that both patient #1 and patient #2 benefited from their individual treatment protocols. The conclusion that we established was that the patient, classified with an unstable spine (lumbar region), would benefit from aquatic rehab, particularly with use of the ALSP vs. traditional land-based lumbar stabilization protocol. The perfect candidate for aquatic therapy must be weaker in the core musculature, with neuromuscular firing issues, but also must be able to maintain neutral spine on the land. Why aquatic therapy works for a patient like this is three fold: (1) the patient was assisted, but also challenged, at maintaining the neutral spine position; (2) the feed forward neuromuscular system, or the ability of the core muscles to fire before the movement of the extremities, protects the spine; and (3) the local stabilizers, particularly, the transverse abdominus, or the primary muscle for lumbar stabilization, is undergoing constant active assisted contraction, which allows for longer and stronger contractions, which improves strength, power and endurance of this muscle.

The goal of this research was to give a real physical therapy diagnosis and treatment plan for subjects suffering from low back pain and unstable spine. The limitations to this design include the following: (1) There were only two participants, because this was a case study. In future research, results would be more generalizable if a randomized control trial experimental design was used. (2) No comparison can be made between the participants. These are, merely, two separate case studies, and the reader must use subjective and objective information to draw conclusions about the research.

The strength of this research included that it provided a real physical therapy treatment plan that can be used by practitioners in the future. (2) The participants were required to maintain lumbopelvic neutral throughout all exercises or the exercises where repeated. (3) The participants were required to perform each exercise correctly at all times in order to progress to the next stage of the protocol.

Review of Research for Chronic Pain and Aquatic Exercise/Therapy Intervention

Dr. Maria Sykorova-Pritz, EdD, Aquatic Exercise Association Research Council

Until recently, claims for the psychological and physical benefits of water exercise for people in chronic pain tended to precede supportive evidence. Results of cross-sectional and longitudinal studies are more consistent and also showed that population with chronic pain condition (arthritis, fibromyalgia, pregnancy-especially low back relief) experienced reduced pain, improved functionally, and experienced better emotional health (anxiety, depression, and self-reported physical impairment). All studies reported long-term benefits from water exercise (the number of days they felt good). For recovery from exercise for elite or endurance athletes, all cold water immersion (CWI) protocols were effective in reducing thermal strain, were more effective in maintaining subsequent high-intensity performance than active recovery, and indicated a significant reduction in muscle soreness 24h post-exercise.

Citation. Munguía-Izquierdo, D., & Legaz-Arrese, A. (2008). Assessment of the effects of aquatic therapy on global symptomatology in patients with fibromyalgia syndrome: A randomized controlled trial. Rheumatology International, 29(2):147-52. Section of Physical Education and Sports, University Pablo de Olavide, Seville, Spain. dmunizq@upo.es; Epub 2008 Jul 4.

Summary

Objectives. To evaluate the effects of a 16-week exercise therapy in a chest-high pool of warm water through applicable tests in the clinical practice on the global symptomatology of women with fibromyalgia (FM) and to determine exercise adherence levels.

Method. A randomized controlled trial. Testing and training were completed at the university. Middle-aged women with FM (n = 60) and healthy women (n = 25) completed a 16-week aquatic training program, including strength training, aerobic training, and relaxation exercises. Measured: Tender point count (syringe calibrated), health status (Fibromyalgia Impact Questionnaire); sleep quality (Pittsburgh Sleep Quality Index); physical (endurance strength to low loads tests), psychological (State Anxiety Inventory), and cognitive function (Paced Auditory Serial Addition Task); and adherence 12 months after the completion of the study.

Results. For all the measurements, the patients showed significant deficiencies compared with the healthy subjects. Efficacy analysis (n = 29) and intent-to-treat analysis (n = 34) of the exercise therapy was effective in decreasing the tender point count and improving sleep quality, cognitive function, and physical function. Anxiety remained unchanged during the follow-up. The exercise group had a significant improvement of health status, not associated exclusively with the exercise intervention. There were no changes in the control group. Twenty-three patients in the exercise group were exercising regularly 12 months after completing the program.

Conclusion. An exercise therapy 3 times a week for 16 weeks in a warm pool could improve most of the symptoms of FM and cause a high adherence to exercise in unfit women with heightened FM symptomatology. The therapeutic intervention's effects can be assessed through applicable tests in clinical practice.

Citation. Tomas-Carus, P., Häkkinen, A., Gusi, N., Leal, A., Häkkinen, K., & Ortega-Alonso, A. (2007). Aquatic training and detraining on fitness and quality of life in fibromyalgia. Medicine and Science in Sport and Exercise, 39(7):1044-50 Fitness and Life quality Laboratory, Faculty of Sports Sciences, University of Extremadura, Cáceres, Spain.

Summary

Objectives. To evaluate the effects of a 12-wk period of aquatic training and subsequent detraining on health-related quality of life (HRQOL) and physical fitness in females with fibromyalgia.

Method. Thirty-four females with fibromyalgia were randomly assigned into two groups: an exercise group, who exercised for 60 min in warm water, three times a week (N = 17); and a control group, who continued their habitual leisure-time activities (N = 17). HRQOL was assessed using the Short Form 36 questionnaire and the Fibromyalgia Impact Questionnaire. Physical fitness was measured using the following tests: Canadian Aerobic Fitness, hand grip dynamometry, 10-m walking, 10-step stair climbing, and blind one-leg stance. Outcomes were measured at baseline, after treatment, and after 3 months of detraining.

Results. After 12 wk of aquatic exercise, significant positive effects of aquatic training were found in physical function, body pain, general health perception, vitality, social function, role emotional problems and mental health, balance, and stair climbing. After the detraining period, only the improvements in body pain and role emotional problems were maintained.

Conclusion. The present water exercise protocol improved some components of HRQOL, balance, and stair climbing in females with fibromyalgia, but regular exercise and higher intensities may be required to preserve most of these gains.

Citation. Munguía-Izquierdo, D., & Legaz-Arrese, A. (2007). Exercise in warm water decreases pain and improves cognitive function in middle-aged women with fibromyalgia. Clinical Experimental Rheumatology, 25(6), 823-833. Section of Physical Education and Sports, University Pablo de Olavide, Seville, Spain. dmunizq@upo.es.

Summary

Objectives. To compare the cognitive function performance in patients with fibromyalgia (FM) with respect healthy controls and to evaluate the short-term efficacy of exercise therapy in a warm, chest-high pool on pain and cognitive function in women with FM.

Method. Sixty middle-aged women with FM were randomly assigned to either an exercise training group (n = 35) to perform 3 sessions per week of aquatic training (32 degrees C) including mobility, aerobic, strengthening, and relaxation exercises for 16 weeks, or a control group (n = 25). Twenty-five healthy women matched for age, weight, body mass index, and educational and physical activity levels were recruited. Pain was assessed in patients using a syringe calibrated like a pressure dolorimeter and a visual analog scale. The severity of FM was evaluated using the Fibromyalgia Impact Questionnaire. Cognitive function was measured in healthy individuals and patients using several standardized neuropsychological tests. All patients were measured at baseline and post-treatment.

Results. At baseline, the healthy group evidenced cognitive performance that was significantly superior to the group of patients with FM in all of the neuropsychological tests. The exercise group significantly improved their pain threshold, tender point count, self-reported pain, severity of FM, and cognitive function, while in the control group the differences were not significant.

Conclusion. An exercise therapy three times per week for 16 weeks in a warm-water pool is an adequate treatment to decrease the pain and severity of FM as well as to improve cognitive function in previously unfit women with FM and heightened painful symptomology.

Citation: Silva, L.E., Valim, V., Pessanha, A.P., Oliveira, L.M., Myamoto, S., Jones, A., & Natour, J. (2008). Hydrotherapy versus conventional land-based exercise for the management of patients with osteoarthritis of the knee: A randomized clinical trial. *Physical Therapy, 88*(1):12-21. Rheumatology Rehabilitation Section, Division of Rheumatology, Federal University of São Paulo, São Paulo, Brazil.; Epub 2007 Nov 6.

Summary

Objective. This study was designed to evaluate the effectiveness of hydrotherapy in subjects with osteoarthritis (OA) of the knee compared with subjects with OA of the knee who performed land-based exercises.

Method. Sixty-four subjects with OA of the knee were randomly assigned to 1 of 2 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.

Results. The 2 groups were homogenous regarding all parameters at baseline. Reductions in pain and improvements in WOMAC and Lequesne index scores were similar between groups. Pain before and after the 50FWT decreased significantly over time in both groups. However, the water-based exercise group experienced a significantly greater decrease in pain than the land-based exercise group before and after the 50FWT at the week-18 follow-up.

Conclusion. Both water-based and land-based exercises reduced knee pain and increased knee function in participants with OA of the knee. Hydrotherapy was superior to land-based exercise in relieving pain before and after walking during the last follow-up. Water-based exercises are a suitable and effective alternative for the management of OA of the knee.

Citation: Kihlstrand, M., Stenmam, B., & Axelsson, O. (2006). Water gymnastics reduced the intensity of back/ low back pain in pregnant women. *Journal of Obstetrical Gynecologic Neonatal Nursing, 35*(4):465-71. Department of Obstetrics and Gynecology, Falu Hospital, Falun, Sweden.

Summary

Objective. To investigate if water-gymnastics during pregnancy may reduce the intensity of back/low back pain and the number of days on sick-leave.

Method. A prospective, randomized study. One hundred and twenty-nine women were randomized to participate in water-gymnastics once a week during

the second half of pregnancy and 129 were randomized to a control group. The women in both groups filled in questionnaires in gestational weeks 18, 34 and within the first postpartum week. Every day from week 18 to labor they assessed the intensity of back/low back pain.

Results. Back pain intensity increased during pregnancy. No excess risk for the pregnancy associated with water-gymnastics was observed. The women participating in water-gymnastics recorded a lower intensity of back/low back pain. The total number of days on sick-leave because of back/low back pain was 982 in the water-gymnastics group (124 women) compared with 1484 in the control group (120 women). After weeks 32 and 33, seven women in the water-gymnastics group compared with 17 in the control group were on sick leave because of back/ low back pain ($p = 0.031$).

Conclusions. Intensity of back/low back pain increased with advancing pregnancy. There was no excess risk for urinary or vaginal infections associated with water-gymnastics. Water-gymnastics during the second half of pregnancy significantly reduced the intensity of back/ low back pain. Water-gymnastics decreased the number of women on sick-leave because of back/low back pain. Water-gymnastics during pregnancy can be recommended as a method to relieve back pain and may reduce the need for sick-leave.

Citation: Granath, A.B., Hellgreen, M.S., Gunnarsson, R.K. (n.d.). Water aerobics reduces sick leave due to low back pain during pregnancy. Research and Development Unit, Primary Health Care in Southern Bohudlan County, Krokslatts vardcentral, Molndal, Sweden. Aina.granath@vgregion.se, PMID: 16881990 (Pub Med-indexed for MEDLINE).

Summary

Objective. To compare the effect of a land-based, physical exercise program versus water aerobics on low back or pelvic pain and sick leave during pregnancy.

Method. Randomized controlled clinical trial in three antenatal care centers. Three hundred ninety healthy pregnant women participate in a land-based physical exercise program or water aerobics once a week during pregnancy. Sick leave, pregnancy-related low back pain or pregnancy-related pelvic girdle pain, or both were measured.

Results. Water aerobics diminished pregnancy-related low back pain ($p = 0.04$) and sick leave due to pregnancy-related low back pain ($p = 0.03$) more than a land-based physical exercise program.

Conclusions. Water aerobics can be recommended for the treatment of low back pain during pregnancy. The benefits of a land-based physical exercise program are questionable and further evaluation is needed.

Citation: Rowsell, G.J., Coutts, A.J., Reaburn, P., Hill-Haas, S. (2009). Effects of cold-water immersion on physical performance between successive matches in high-performance junior male soccer players. *Journal of Science and Medicine in Sport, 12*(3):417-421. South Australian Sports Institute, Kidman Park, SA, Australia. rowsell.greg@saugov.sa.gov.au,.Epub 2008 Jun 11.

Summary

Objective. To investigate the effect of water immersion on physical test performance and perception of fatigue/recovery during a 4-day simulated soccer tournament.

Method. Twenty high-performance junior male soccer players (age 15.9 ± 0.6 years) played four matches in 4 days and undertook either cold-water immersion (10 ± 0.5 degrees C) or thermoneutral water immersion (34 ± 0.5 degrees C) after each match. Physical performance tests (countermovement jump height, heart rate, and rating of perceived exertion after a standard 5-min run and 12 × 20-m repeated sprint test), intracellular proteins, and inflammatory markers were recorded approximately 90 min before each match and 22 h after the final match. Perceptual measures of recovery (physical, mental, leg soreness, and general fatigue) were recorded 22 h after each match.

Results. There were non-significant reductions in countermovement jump height (1.7-7.3%, $P = 0.74$, $\eta^2 = 0.34$) and repeated sprint ability (1.0-2.1%, $P = 0.41$, $\eta^2 = 0.07$) over the 4-day tournament with no differences between groups. Post-shuttle run rating of perceived exertion increased over the tournament in both groups ($P < 0.001$, $\eta^2 = 0.48$), whereas the perceptions of leg soreness ($P = 0.004$, $\eta^2 = 0.30$) and general fatigue ($P = 0.007$, $\eta^2 = 0.12$) were lower in the cold-water immersion group than the thermoneutral immersion group over the tournament. Creatine kinase ($P = 0.004$, $\eta^2 = 0.26$) and lactate dehydrogenase ($P < 0.001$, $\eta^2 = 0.40$) concentrations increased in both groups but there were no changes over time for any inflammatory markers.

Conclusion. These results suggest that immediate post-match cold-water immersion does not affect physical test performance or indices of muscle damage and inflammation but does reduce the perception of general fatigue and leg soreness between matches in tournaments.

Citation. Hamlin, M.J. (2008). The effect of contrast temperature water therapy on repeated sprint performance. *Sports Science, 26*(5):431-40. Social Sciences Tourism & Recreation Group, Lincoln University, Canterbury, New Zealand. hamlinm@lincoln.ac.nz,

Summary

Objective. To compare the effectiveness of two recovery techniques on blood lactate and repeated sprint performance.

Method. In a randomized cross-over design 20 junior representative rugby players (aged 19 +/-1years) were given either contrast temperature water therapy or active recovery after performing a repeated sprint test. The test was then repeated 1h later to gauge the effects of the two recovery methods on subsequent repetitive sprinting performance. One week later, the two groups were reversed and the testing repeated. The test consisted of ten 40-m sprints with a 30-s turn-around between sprints. Recovery consisted of 6 min slow jogging (6.8 km h^{-1}) for the active recovery group or 6 min of contrast temperature water therapy consisting of three 1-min hip-height immersions in cold water (8-10 degrees C) alternated

with three 1-min hot water (38 degrees C) showers. Blood lactate concentration and heart rates were measured throughout the testing.

Results. Relative to the active recovery group the contrast temperature water therapy group showed a substantial decrease in blood lactate concentration 3 min after the procedure (-2.1 mmol L^{-1}, 95% confidence limits, ± 1.8 mmol L^{-1}), and substantially lower heart rates both during the procedure (-9.1± 8.7 min^{-1}) as well as 1h later during the second set of sprints (-11.7 ± 8.6 min^{-1}). Effects of recovery group on repeated sprint performance were small to trivial and unclear.

Conclusion. Compared to active recovery, contrast temperature water therapy decreases blood lactate concentration and heart rate but has little effect on subsequent repetitive sprinting performance.

Citation. Buchheit, M., Peiffer, J.J., Abbiss, C.R., & Laursen, P.B. (2009). Effect of cold water immersion on post-exercise parasympathetic reactivation. Journal of Science and Medicine in Sport, 12(1): 91-6. Research Laboratory, EA 3300 Exercise Physiology and Rehabilitation, Faculty of Sports Sciences, University of Picardie, Jules Verne, Amiens, France. martin.buchheit@u-picardie.fr, Epub 2008 Feb 20.

Summary

Objective. To compare the efficacy of hot/cold contrast water immersion (CWI), cold-water immersion (COLD) and no recovery treatment (control) as post-exercise recovery methods following exhaustive simulated team sports exercise.

Method. Repeated sprint ability, strength, muscle soreness and inflammatory markers were measured across the 48-h post-exercise period. Eleven male team-sport athletes completed three 3-day testing trials, each separated by 2 weeks. On day 1, baseline measures of performance (10 m × 20 m sprints and isometric strength of quadriceps, hamstrings and hip flexors) were recorded. Participants then performed 80 min of simulated team sports exercise followed by a 20-m shuttle run test to exhaustion. Upon completion of the exercise, and 24 h later, participants performed one of the post-exercise recovery procedures for 15 min. At 48 h post-exercise, the performance tests were repeated. Blood samples and muscle soreness ratings were taken before and immediately after post-exercise, and at 24 h and 48 h postexercise.

Results. In comparison to the control and CWI treatments, COLD resulted in significantly lower ($p < 0.05$) muscle soreness ratings, as well as in reduced decrements to isometric leg extension and flexion strength in the 48-h post-exercise period. COLD also facilitated a more rapid return to baseline repeated sprint performances.

Conclusion. The only benefit of CWI over control was a significant reduction in muscle soreness 24 h postexercise. This study demonstrated that COLD following exhaustive simulated team sports exercise offers greater recovery benefits than CWI or control treatments.

The Evolution of Resistance Training in the Aquatic Environment

June M. Chewning, MA, Aquatic Exercise Association Research Committee, Fitness Learning Systems Education Specialist

In watching research funnel through the Aquatic Exercise Association Research Committee, it was particularly interesting in the mid 1990s to see research emerge on comparison studies for rehabilitation on land as opposed to in the water. Although rehabilitation in the water could still benefit from additional research, there is evidence that rehabilitation in the water did transfer to similar improved function on land.

One study in particular caught the committee's attention: "Comparison of the effects of exercise in water and on land on the rehabilitation of patients with intra-articular anterior cruciate ligament reconstruction" (Tovin et al, 1994). This study concluded that "Although exercise in water may not be as effective as exercise on land for regaining maximum muscle performance, rehabilitation in water may minimize the amount of joint effusion and lead to greater self-reports of functional improvement in subjects with intra-articular ACL reconstructions." When looking more closely at the methods of the study, it is apparent that the training modes used for land and water were not very comparable. Step exercises were used both on land and in the water. Step muscle physiology is very different in the water compared to land due to the reduction of body mass associated with the water's buoyancy, and the water's resistance.

In addition, the land resistance was progressively overloaded systematically with pulleys and stack weights. In the water, the resistance was self-paced with a Hydrotone drag resistance exercise boot. The question arose as to how to measure and quantify workload in the aquatic environment for resistance training.

In the 1980s and 1990s aquatic research looked primarily at the cardiovascular response to exercise in the aquatic environment. The causes and effects of heart rate bradycardia were investigated and recommended heart rate deductions for water exercise were established. There was an overriding question that permeated the research: If your heart rate is lower in the water, is the workout less effective? That question has been laid to rest and is exemplified with the conclusion of a study conducted by Gappmaier et al. (2006), "results indicate that there are no differences in the effect of aerobic activities in the water versus weight-bearing aerobic exercise on land on body composition components as long as similar intensity, duration, and frequency are used."

What about resistance training in the water? Is force production comparable to land? Are there differences in electromyography (EMG)? Is it possible to perform resistance train in the water according to American College of Sports Medicine guidelines? Can you strength train in the water?

The aquatic industry thought process for resistance training went through 2 stages. The first stage recommendations were reasonably vague. These basically included:

- Training in the water primarily builds muscular endurance.
- Water creates resistance in all planes of motion and in all directions.
- You can't really build strength effectively in the water.

After research advanced, the second set of guidelines became a little more specific and applied key biomechanical concepts. These basically included the following:

In the water, the following factors must be considered and controlled when resistance training:

- The length of the limb.
- Equipment factors: surface (drag) area, level of buoyancy, amount of weight, or tension of the rubberized equipment.
- The velocity or speed of movement.
- Controlling range of motion is important in progressive overload.

Using these basic concepts, you can progressively overload in aquatic resistance training in three ways:

- More repetitions (increase speed) through full range of motion within the same period of time.
- More repetitions through full range of motion at the same rate of speed; this option will take a longer period of time.
- Systematically increase the frontal surface area, buoyancy, or resistance depending on the type of equipment being used.

Even though these guidelines were less vague, there was very little scientific evidence available to make them more concrete. The Aquatic Exercise Association listed investigating resistance training in the water as a primary research need for the aquatic industry.

In the past decade, there are 2 primary research groups who have looked at resistance training in the aquatic environment. The first is a research group from Finland, led by Tapani Poyhonen. This group's research focuses on knee flexion and extension, EMG activity, drag forces, drag coefficients, progressive resistance overload, and knee rehabilitation exercises (see Summary of Research Table 1).

Initial studies by this group investigated EMG responses, force output, and drag coefficients. There were two training studies conducted. The aquatic training protocols used in the 2 training studies were developed based on previous research conducted by the group. Workload progressed by manipulating all variables:

- Sets: 2-4
- Repetitions per set: 12-30
- Duration using a designated period of time (30 to 45 seconds)
- Resistance: different sized drag boots
- Perceived exertion on the 6-20 scale was measured and they were encouraged to work at maximal effort

Recommendations included the use of a timing device (duration and repetitions), systematically varying the load of the equipment, and use of perceived exertion. By carefully controlling these variables, the researchers were able to create progressive overload training protocols that produced significant physiological improvement. (For protocols, see Poyhonen et al 2002 and 2010)

Table 1 Summary of Research

Poyhonen et al., 1999	Determination of trial-to-trial and day-to-day reproducibility of isometric force and electromyographic activity (EMG) of the knee extensor muscles in water and on dry land as well as to make comparisons between the two training conditions in muscle activity and force production. Healthy subjects performed isometric contractions in the same patient elevator chair measuring isometric force and EMG in the water and on dry land. High trial-to-trial reproducibility was indicated for force and EMG for underwater and dry land. Day-to-day reproducibility for submaximal contractions was similar.
Poyhonen et al., 2000	Measurement of hydrodynamic drag forces in barefoot/hydro-boot conditions and to determine the coefficients of drag on a human leg/foot model during simulated knee extension-flexion exercise. A lower leg human prosthesis was used in a water tank to measure drag coefficients during lower leg flexion and extension. Drag force and coefficient were highest during the early part of extension (150-140 degrees flexion). Effect of velocity was remarkable on drag forces, but minimal on drag coefficient values. The drag forces and coefficients can be clinically used to calculate hydrodynamic forces to develop progressive knee exercise programs and to design prosthesis for amputee patients.
Poyhonen et al., 2001	Comparison of muscle activity and resistive drag force during knee extension-flexion exercises in the water and on dry land with a bare foot and a hydroboot. Healthy subjects performed exercises while seated on an elevator chair while isokinetic and isometric forces were measured with a dynometer, EMG activity was recorded and underwater drag for range of motion was calculated using the general fluid equation. Increasing frontal surface area with the Hydro-boot significantly increased water resistance, providing flexion forces that approach those measured on dry land. Hydrodynamic principles and forces must be considered to ensure appropriate progression.

(continued)

Table 1, *continued*

Poyhonen et al., 2001	Evaluated muscle function and kinematics during commonly used knee rehabilitation exercises performed in water. Healthy participants performed maximal effort single extension and flexion trials barefoot in still and flowing water measuring EMG and angular velocities. The data demonstrated that the flowing properties of water modified the neuromuscular function (concentric/eccentric) of the quadriceps and hamstring muscles acting as agonists and antagonists in the knee exercises. This should be taken into account when planning therapeutic water exercises.
Poyhonen et al., 2002	Investigated the effects of a progressive 10 week aquatic resistance training program on neuromuscular performance and muscle mass of knee extensors/flexors. Healthy women did pre and post testing for maximal knee extension/flexion exercises with EMG and a tomography scan was used to measure muscle mass. Exercise or control group assigned. Significant improvement was noted in muscle torque and neural activation with a significant increase in muscle mass.
Valtonen, 2010	Studied the effects of aquatic resistance training on mobility, muscle power, and cross-sectional area. Patients 4-18 months after unilateral knee replacement participated in a 12 week progressive aquatic resistance training program or in a control (no intervention) group. Mobility limitation accesses by walking speed and stair ascending time and self reported with WOMAC questionnaire. Knee extensor and flexor power were assessed using isokinetic torque and tomography scan. Walking speed increased 9%, stair ascending time decreased 15% in the aquatic training group compared to changes in control group. No significant differences in the WOMAC scores. Knee flexor/extensor power increase in both legs as did muscle mass in both legs as compared to the controls.

The second research group is from Spain, and the primary researcher is Juan C. Colado. This group investigated aquatic resistance training as a viable alternative for general and athletic populations. They believe that resistance training in the water is not widely used because there were no methods for controlling and monitoring intensity. They conducted 7 research investigations and then formulated a method for creating progressive overload for resistance training in the water (see Summary of Research Table 2).

American College of Sports Medicine (ACSM) guidelines for resistance training are the primary standards used for training the general population. The researchers assumed and investigated the concept that regardless of the material used, if the muscle was properly stimulated, then physiological adaptation would occur. They found that muscle can be adequately stimulated in the aquatic environment proving this fundamental concept to be true. This pairs the fundamental concepts for both cardiorespiratory and resistance training in the aquatic environment: as long as appropriate training volume and intensity are applied, adaptation occurs. This fundamental concept stresses the importance of proper planning, progression, and application of volume and intensity in aquatic training for both the cardiorespiratory system as well as the musculoskeletal system in order to more effectively achieve desired training results.

Electromyography, controlled cadence, progressively sized drag equipment, and water currents were used to compare land and water resistance training exercises using fit young men, postmenopausal women, and the general population as subjects. EMG measurements for this group were primarily focused on the pectoralis and posterior deltoid muscles testing glenohumeral adduction and abduction movement in the transverse plane. They also investigated EMG in trunk muscles finding that activation of the erector spinae lumborum was significantly higher in the aquatic medium. Good form and technique as well as adequate strength in the stabilizing trunk musculature is recommended before performing aquatic resistance training exercises with high resistance/intensity.

In a summary paper (Colado & Triplet, 2009) recommendations and guidelines are given to maximize success in an aquatic resistance training program through proper monitoring of volume and intensity.

Objective Recommendations/ Guidelines for program design with devices that increase drag force (DIDF): (adapted from Colado & Triplett, 2009)

- The same program design recommendations used for land resistance training should also be used for the aquatic environment to determine load, volume and progression.

1. You must have combined control of:

- Cadence / movement pace
- Size of the equipment (surface area)
- Length of the extremity (lever arm)
- Hydrodynamic position of the moving segment and device used
- Perception of effort at predetermined number of reps using the OMNI Resistance Exercise Scale (OMNI-RES)

Table 2 Summary of Research Chart

Colado et al., 2006	Verified if the cardiovascular and metabolic demands of an aquatic resistance exercise are comparable to the land-based equivalent. Subjects were evaluated using a horizontal shoulder adduction movement in water with a pair of Hydro-Tone Bells, and on land with an elastic band (EB). The movement cadence was determined, as well as the appropriate hand position on the elastic band, in order to achieve the desired number of repetitions for muscular fatigue, which was 25. Conclusion: The aquatic resistance exercise will produce a similar physiological response to that produced by performing the comparable land-based exercise.
Colado et al., 2006	Determined whether the level of activation achieved with aquatic resistance exercises in trained subjects is comparable to that achieved with their dry land exercise equivalents. Surface electromyography was used to determine the muscular activity of the agonist muscles of the movements of gleno-humeral adduction and abduction on a horizontal plane, and certain muscles of the trunk. The activation of the erector spinae lumborum was significantly greater in the aquatic medium. However, these exercises should not be used with subjects who lack good exercise technique and whose stabilizing trunk musculature is not in excellent condition.
Colado et al., 2006	Verified whether the controlled use of water currents during aquatic strength training increases the muscular activity of certain trunk stabilizing muscles. A series of 15 repetitions at 9 to 10 on the OMNI perceived exertion scale for a resistance exercise of gleno-humeral adduction and abduction movements on a horizontal plane with Hydro-Tone Bells was performed. After a 5-minute rest, subjects repeated the test while receiving water currents at 30 per minute at a force of 68.55 N from the front. Surface electromyography was used to determine the muscular activity of rectus abdominus, lumbar erector spinae, and medial fibers of the external oblique. The controlled use of water currents during aquatic strength training increases the muscular activity of the trunk stabilizing muscles.

(continued)

Table 1, *continued*

Colado et al., 2006	Investigated the effect on body composition of a periodized program for physical conditioning (PPC) carried out in deep water compared to an equivalent PPC carried out on dry land. A 16-week PPC was performed with a frequency of 3 days per week. The aquatic group (AG) used flotation belts and the subjects were able to move and balance effectively while wearing them. The AG also used devices that increased drag force, which were sized to best allow each subject to adapt to the prescribed intensity. The effect on body composition was the same, independent of whether the program was performed in deep water or on dry land.
Colado et al., 2007	Identified the effects of a periodized aquatic program for strength training (PAPST) on selected cardiovascular parameters in early-postmenopausal women. The aquatic exercise group trained for 24 weeks with a periodized program for local muscular endurance based on OMNI perceived exertion scale for resistance exercise and with devices that increased drag force, which were sized to best allow each subject to adapt to the prescribed intensity. The PAPST reduced the risk of cardiovascular disease by improvements in systolic and diastolic blood pressure, total cholesterol, LDL-cholesterol, glucose, apolipoprotein B, triglycerides, waist perimeter and total fat mass.
Colado et al., 2008	Examined whether monitoring of both the rhythm of execution and the perceived effort adjusted at a certain number of repetitions is a valid tool for reproducing the same intensity of effort in different sets of the same aquatic resistance exercise. Muscle activation was recorded for 15 repetitions at maximum or near maximum effort by using surface electromyography in the pectoralis major and posterior deltoid for transverse adduction and abduction. The same intensity was achieved in a transverse adduction and abduction aquatic resistance exercise with different sets of the same exercise.
Colado et al., 2009	Analyzed the effects of a short-term periodized aquatic resistance program (PARP) on maximum strength, power and body composition in fit young men. The PARP was an 8-week supervised program performed 3 days per week. It consisted of a total-body resistance exercise workout using aquatic devices that increased drag force, with a controlled cadence of movement that was adjusted individually for each exercise and subject. The volume and intensity of the program were increased progressively. The PARP produced significant improvements in strength, power and fat-free mass and thus appears to be a very effective form of resistance exercise.

Adapted from Colado/Triplett (2009).

2. Monitor pace with beats per minute or a device like a metronome.
- The resistance provided by the water is always the same.
- Use the same form and technique through full ROM.
- When you increase the pace, resistance increases exponentially.
3. When necessary, increase DIDF to the amount necessary to keep a prescribed pace of movement and reach the desired number of reps and level of effort.
4. Increase the pace of movement with same size DIDF.

Recommended Steps to Determine Intensity of Aquatic Resistance Exercises: (Colado & Triplett, 2009)

1. Determine desired rep range based on client goals and training history.
2. Determine desired level of exertion
- Use the OMNI-RES Scale (This is a scale that was developed for resistance training which is similar to the Borg Scale.)
- You can also use the OMNI scale to vary intensity
3. Choose the appropriate DIDF
- Based on the client's reps and exertion level
- This may involve a trial and error process just as for land RT
- The cadence should be the maximal possible allowing the exerciser to complete targeted reps at the targeted OMNI-RES level
- Cadences are commonly between 44 and 64 beats per minute

The future looks much clearer for resistance training in the aquatic environment. With the help of vital research, recommendations and guidelines for exercise in the water continue to progress. As health-fitness professionals continue to put research into practice, more people will come to the water and experience success in rehabilitation, general fitness, and athletic training.

Bibliography

Exercise Association. (2010). *Aquatic Fitness Professional Manual* (6th Ed.). Champaign, IL: Human Kinetics .

Colado, J., Escudero, J., Jimenez, A., Naclerio, F., & Chulvi, I. (2006). Comparison of the muscular activation achieved by resistance exercises carried out in water and on dry land. *Journal of Strength and Conditioning Research*, *20*, e22.

Colado, J., Tella, V., & Triplett, N. (2008). A method for monitoring intensity during aquatic resistance exercises. *Journal of Strength and Conditioning Research*, *22*, 2045-2049.

Colado, J., Tella, V., Triplett, N., & Gonzalez, L. (2009). Effects of a short-term aquatic resistance training program on strength and body composition in fit young men. *Journal of Strength and Conditioning Research*, *23*, 549-559.

Colado, J., Tella, V., & Llop, F. (2006). Response to resistance exercise performed in water versus on land. *Rev Port CIen Desp*, *6*(Suppl2), 361-365.

Colado, J., & Tella, V. (2006). Effects of water currents on the muscular activation of certain trunk stabilizing muscles. *Archives of Physical Medicine Rehabilitation*, *87*, e30-31.

Colado, J., Pablos, C., Naclerio, F., Tella, V., & Chulvi, I. (2006). Effects on Body Composition of an integral program for the physical conditioning carried out in deep water vs on dry land. *Journal of Strength and Conditioning Research*, *20*, e22.

Colado, J., Saucedo, P., Tella, V., Naclerio, F., Chulvi, I., & Abellan, J. (2007). Effects of an aquatic strength training program on certain cardiovascular risk factors in early postmenopausal women. *Medicine and Science in Sports and Exercise*, *39*(suppl 5), S422.

Colado, J., & Triplett, N. (2009). Monitoring the intensity of aquatic resistance exercises with devices that increase the drag force: an update. *Journal of Strength and Conditioning Research*, *31*(3), 94-100.

Gappmeier, E., Lake, W., Nelson, A., & Fisher, A. (2006). Aerobic Exercise in water versus walking on land: Effects on indices of fat reduction and weight loss of obese women. *Journal of Sports Medicine and Physical Fitness*, *46*(4), 564-9.

Poyhonen, T., Keskinen, K., Hautala, A., Savolainen, J., & Malkia, E. (1999). Human isometric force production and electromyographic activity of knee extensor muscles in water and on dry land. *European Journal of Applied Physiology and Occupational Physiology*, *80*(1), 52-6.

Poyhonen, T., Keskinen, K., Hautala, A., & Malkia, E. (2000). Determination of hydrodynamic drag forces and drag coefficients on human leg/foot model during knee exercise. *Clinical Biomechanics*, *15*(4), 256-60.

Poyhonen, T., Keskinen, K., Kyrolainen, H., Hautala, A., Savolainen, J., & Malkia, E. (2001). Neuromuscular function during therapeutic knee exercise under water and on dry land. *Archives of Physical Medicine and Rehabilitation*, *82*(10), 1446-52.

Poyhonen, T., & Avela, J. (2002). Effect of head-out water immersion on neuromuscular function of the plantarflexor muscles. *Aviation and Space Environmental Medicine*, *73*(12), 1215-8.

Poyhonen, T., Sipila, S., Keskinen, K., Hautala, A., Savolainen, J., & Malkia, E. (2002). Effects of aquatic resistance training on neuromuscular performance in healthy women. *Medicine and Science in Sports and Exercise*, *34*(12), 2103-9.

Tovin, B., Wolf, S., Greeenfield, B., Crouse, J., & Woodfin, B. (1994). Comparison of the effects of exercise in water and on land on the rehabilitation of patients with intra-articular anterior cruciate ligament reconstruction. *Physical Therapy*, *74*(8), 710-19.

Valtonen, A., Poyhonen, T., Sipila, S., & Heinonen, A. (2010). Effects of aquatic resistance training on mobility limitation and lower limb impairments after knee replacement. *Archives of Physical Medicine Rehabilitation*, *91*(6), 833-839.