

Aquatic Exercise and the Athlete

Research Enhanced Presentation IAFC 2011

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Aquatic Cardiovascular Training

Heart Rates at Equivalent Submaximal Levels of VO₂ Do Not Differ Between Deep Water Running and Treadmill Running

Mercer, John A.; Jensen, Randall L.

Journal of Strength & Conditioning Research. 12(3):161-165, August 1998.

Objective: To compare submaximal heart rate (HR) and oxygen consumption (VO₂) during deep water running (DWR) and treadmill running (TMR).

Results: There were no significant differences in heart rates at equivalent submaximal VO₂ levels between tests for either gender.

Application: The heart rate response to submaximal exercise in the water is similar to that on a treadmill. Athletes will be able to maintain or improve cardiovascular fitness while jogging in the water provided that they maintain a similar intensity level as they would on land.

A Lower-Extremities Kinematic Comparison of Deep-Water Running Styles and Treadmill Running

KILLGORE, GARRY L.; WILCOX, ANTHONY R.; CASTER, BRIAN L.; WOOD, TERRY M.

Journal of Strength & Conditioning Research. 20(4):919-927, November 2006.

Objective: The purpose of this investigation was to identify a deep-water running (DWR) style that most closely approximates terrestrial running, particularly relative to the lower extremities.

Results:

The cross country (CC) style of DWR was found to be similar to treadmill running (TR) with respect to linear ankle displacement, whereas the high knee (HK) style was significantly different from TR in all comparisons made for ankle and knee displacement.

The CC style of DWR is recommended as an adjunct to distance running training if the goal is to mimic the specificity of the ankle linear horizontal displacement of land-based running, but the stride rate will be slower at a comparable percentage of VO₂max.

Application:

DWR may be effective as a supplement to a training program.

The effectiveness will be improved if the mechanics in the water are similar to the mechanics of CC running

A Kinematic Comparison of Deep Water Running and Overground Running in Endurance Runners

KILDING, ANDREW E.; SCOTT, MARK A.; MULLINEAUX, DAVID R.

Journal of Strength & Conditioning Research. 21(2):476-480, May 2007

Objective: Deep water running (DWR) is commonly used as a rehabilitative tool or as a running specific cross-training modality. However, because little is known about the biomechanical specificity of this training, the aim of this study was to compare the leg kinematics of DWR vs. overground running (OGR).

Results:

Leg motion was different between DWR and OGR both kinematically and in coordination.

The time lag indicates that the hip and knee flex and extend together in DWR, whereas the hip moves before the knee during OGR.

Stride frequency had an effect on OGR but not on DWR.

Application:

The apparent differences between DWR and OGR are likely to affect muscle recruitment patterns and this could be problematic for athletes with hip and knee injuries.

Because the negative effects of DWR as a rehabilitative tool are not known, gradual familiarization to DWR prior to a prescribed DWR rehabilitation or intense fitness maintenance program is recommended to offset any adverse affects.

A Comparison of the Physiological Exercise Intensity Differences Between Shod and Barefoot Submaximal Deep-Water Running at the Same Cadence

Killgore, Garry L; Coste, Sarah C; O' Meara, Susan E; Konnecke, Cristina J
Journal of Strength & Conditioning Research. 24(12):3302-3312, December 2010.

Objective: The purpose of this investigation was to identify whether physiological exercise intensity differed with the use of aquatic training shoes (ATS) during deep-water running (DWR) compared to using a barefoot condition.

Results:

There were statistically significant differences for energy expenditure, $\dot{V}O_2$, RPE and respiratory exchange ratio (RER) between the two groups.

The results showed an increase in energy expenditure and $\dot{V}O_2$ and a significantly higher RPE and RER for DWR with an ATS.

The results also revealed significantly higher RPE and RER values while DWR with an ATS compared to those found in treadmill running (TR).

Application:

Wearing the ATS be recommended as a method of significantly increasing the exercise intensity while running in deep water as compared to not wearing a shoe.

Shod (barefoot) compared to TR yields very small differences, which indicates that the shoes may help better match land-based running exercise intensities.

Aquatic Plyometric Training

Two-Leg Squat Jumps in Water: An Effective Alternative to Dry Land Jumps

Colado JC, Garcia-Masso X, Gonzalez LM, Triplett NT, Mayo C, Merce J (2010). International Journal of Sports Medicine.

Objective: To study the kinetic & kinematic differences in female athletes in double-leg jumps in an aquatic environment compared to land & to determine how the use of equipment can increase drag force and change jump mechanics.

Results:

-peak impact force rate was lower in the aquatic groups

-peak concentric force was higher in the aquatic groups.

Application:

-water affords an ideal environment for jump training

-exercise intensity variables are enhanced while impact forces are diminished SO the participants will receive all of the benefits of jump training avoiding joint damage and strain.

Concentric and Impact Forces of Single-Leg Jumps in an Aquatic Environment versus on Land

Triplett TN, Colado JC, Benavent J, Alakhadar Y, Madera J, Gonzalez LM, Tella V (2009). Medicine & Science in Sport & Exercise.

Objective: To study the kinetic & kinematic differences in female athletes in single-leg static jumps in an aquatic environment compared to land & to determine how the use of equipment can increase drag force and change jump mechanics.

Results:

-jump propulsion was significantly higher in both aquatic groups compared to the land jump-jump with devices generated a higher value of peak concentric force

-impact force was sig. lower in aquatic environment with the lowest impact value being with devices (44.8% less & 62.9% less with devices). 2.38 x body weight on land & 1.31 x body weight in water & .88 x body weight in water w/ devices.

Application:

- Intensity was GREATER in the aquatic groups SO volume of training should be a consideration when planning Aquatic Plyometric training.
- Impact forces were LOWER in the aquatic groups SO joint strain and prospect of injury from Aquatic Plyometric Training is heavily reduced making it a more viable technique for a wider variety of populations.

Chest- and Waist-Deep Aquatic Plyometric Training and Average Force, Power, and Vertical-Jump Performance

Miller MG, Cheatham CC, Porter AR, Ricard MD, Hennigar D, Berry DC (2007). International Journal of Aquatic Research and Education.

Objective:

To compare effects of chest- and waist-deep water aquatic plyometrics on average force, power & vertical jump.

Results: No significant differences were found in average force & power or in vertical jump.

Application: Aquatic Plyometric training can be done in varying water depths while maintaining effectiveness for increasing force, power and vertical jump.

Comparison of Land- and Aquatic-Based Plyometric Training on vertical Jump Performance

Stemm JD, Jacobson BH (2007). Journal of Strength and Conditioning Research.

Objective: To compare land-based and aquatic-based plyometric exercises on vertical jump performance.

Results: No significant difference in the land and aquatic group in vertical jump.

Application:

-both land and water plyometric training achieve the goal of improving vertical jump.

But the aquatic environment does this without the large increase in joint load and stress.

-The inclusion of plyometric training in aquatic exercise sessions will allow improvements in vertical jump which is a measurement that denotes power, strength and force production – all important foundational components in balance!

Aquatic Balance and Agility Training

Improvements in Balance and Agility After High Intensity Water Exercise for Land-based Athletes: 2920: Board #67 May 30 9:30 AM - 11:00 AM

Whitehill JJr; Constantino NL, Sanders ME, Lu M (2009). Medicine & Science in Sport & Exercise

Objective: To determine effectiveness of water-based exercise on agility and balance performance by land-based competitive athletes during off-season training.

Results:

-The study reported greater improvements in all measures for agility and balance when compared to controls.

-While both groups had improvements, the Water Exercise group improved significantly more than the land-based off-season training group.

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Influence of the Water on Exercise Recovery

“Effect of water immersion methods on post-exercise recovery from simulated team sport exercise.”

Ingram J, Dawson B, Goodman C, Wallman K, Beilby J.

J Sci Med Sport. 2009 May;12(3):417-21. E-pub 2008 Jun 11.

Objective: To compare the efficacy of hot (37°C-43°C/ cold (12°C-15°C) contrast water immersion (CWI), cold-water immersion (COLD) and no recovery treatment (control) as post-exercise recovery methods following exhaustive simulated team sports exercise.

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. The only benefit of CWI over control was a significant reduction in muscle soreness 24h post-exercise.

Conclusion: Study demonstrated that COLD following exhaustive simulated team sports exercise offers greater recovery benefits than CWI or control treatments.

“Effect of hydrotherapy on recovery from fatigue”

Vaile J, Halson S, Gill N, Dawson B.: Int J Sports Med. 2008 Jul;29(7):539-44. E-pub 2007 Nov 30.

Objective: The effects of three hydrotherapy interventions on next day performance recovery following strenuous training.

Results: Performance (average power), core temperature, heart rate (HR), and rating of perceived exertion (RPE) were recorded throughout each session. Sprint (0.1 - 2.2 %) and TT (0.0 - 1.7 %) performance were enhanced across the five-day trial following CWI and CWT, when compared to HWI and PAS. Additionally, differences in rectal temperature were observed between interventions immediately and 15-min post-recovery.

Conclusion: Overall, no significant differences were observed in HR or RPE regardless of day of trial/intervention. CWI and CWT appear to improve recovery from high-intensity cycling when compared to HWI and PAS, with athletes better able to maintain performance across a five-day period.

“Relaxation effects in humans of underwater exercise of moderate intensity.”

Oda S, Matsumoto T, Nakagawa K, Moriya K. Eur J Appl Physiol Occup Physiol. 1999 Sep;80(4):253-9.

Objective: To investigate the effects of underwater exercise in warm water (34 degrees C) on physiological and psychological relaxation.

Results: The results of %HRmax indicated that the intensity of underwater exercises practiced in the experiments ranged from low to moderate. The power % of EEG alpha bands had increased significantly after the underwater exercise compared with the pre-exercise rest ($P < 0.05$). From the POMS results, we observed that positive mood (vigor) increased and negative mood (tension and anxiety, depression and dejection) decreased significantly after the underwater exercise ($P < 0.05$).

Conclusion: This study found that the subjects showed increased physiological and psychological indices of relaxation after underwater exercise.

“Cold water recovery reduces anaerobic performance.”

Crowe MJ, O'Connor D, Rudd D Int J Sports Med. 2007 Dec;28(12):994-8. E-pub 2007 May 29.

Objective: This study investigated the effects of cold water immersion (12°C-15°C) on recovery from anaerobic cycling.

Results: Peak power, total work and post exercise blood lactate were significantly reduced following cold water immersion compared to the first exercise test and the control condition. These variables did not differ significantly between the control tests. Peak exercise heart rate was significantly lower after cold water immersion compared to the control. Time to peak power, rating of perceived exertion, and blood pH were not affected by cold water immersion compared to the control. Core temperature rose significantly (0.3 degrees C) during ice bath immersion but a similar increase also occurred in the control condition.

Conclusion: Cold water immersion caused a significant decrease in sprint cycling performance with one-hour recovery between tests.