"The Art and Science of Aquatic Training for Running Conditioning and Rehabilitation"
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PREFACE

- "Keep a mind that is open to everything and attached to nothing" (Tolopa, 10th Century Philosopher)

Preface

- Understanding and appreciating "Individual Response" is one of the basic scientific tenets of training
- We MUST maintain an objectivity that embraces the runner as a "whole" individual
- To ignore the complex interrelationships inherent in humans, is to risk poor performances, illness, and/or injury

Why run in the water?

- Running has been described as "essentially a series of collisions with the ground" (McMahon & Greene, 1979)
- These collisions create VGRF's of 1.5 to 3 times the runner's BW (16, 25, 33, 37, 49) at an "easy" pace, and up to 5-6 BW as the pace increases (81)
- It has been estimated that up to 70% of runners will incur a running-related injury (16, 82, 98)

Why run in the water?

A method of decreasing the volume of the running impact forces and the negative effects of excessive mileage is to supplement a runner's training program using deep-water running (DWR) in a pool (20, 32, 41, 42, 44, 50, 58, 65, 68, 85, 89, 101, 104, 116, 121, 122).

Why run in water?

- A rationale for deep-water running (DWR) is that it allows the runner to train using a similar movement pattern to that found on land (Specificity Principle) without incurring the impact forces, and thus greatly reducing the repetitive loading of the musculoskeletal system (27, 44, 76, 109).

Why run in water?

- This alternative training method has been reported to decrease spinal and joint compressive loading, which would decrease the likelihood of incurring running-related injuries (37, 54).

Specific Injury Prev/Rehab Example: Stress Fractures

- Runners suffer an incidence rate of 4-14% in a normal running population (Burr, 1997)
- These rates are typically much higher in the collegiate ranks (sometimes as high as 35-50% in some programs)
- Linfield's program = <1% in 19+ yrs. as the Head Coach due in large part to the proper application of a balanced program.

Specific Injury Example: Stress Fractures

- Turner's (1998) Rules for Bone Adaptation:
- 1. Dynamic rather than static loading drives bone adaptation.
- 2. Law of Diminishing Returns - too much of a "good thing", i.e. running
- 3. Novel approach promotes further adaptation

Specific Injury Example: Stress Fractures

- Application of Turner's Rules for Bone Adaptation (1998) to proper training in the water:
- Rule #1: Use more plyometrics or similar power/speed drills in the shallow water, e.g. bounding, tuck jumps, jump squats, speed drill series, etc. to provide for more dynamic stimuli

Specific Injury Example: Stress Fractures

- Rule #2: Decrease the overall land-based mileage by using more days/sessions in the pool. This will vary depending on the time of season, individual response, fitness, goals, etc.
- Rule #3: The novelty of using the water is obvious (adaptation)

Shallow water

- In a comparison of aquatic and land-based plyometric training, it was found that there is no statistical difference between the 2 media, using the VJ as the test of power (Stemm & Jacobsen, 2007)
- Similar results found on VB players (Martel, Harmer, Logan, &Parker, 2005)
- This means we can use plyo's, etc. to help reduce injuries too, e.g. stress fractures, AND assist with gait efficiency!

Understanding movement in water

- Before we can maximize the usage of water as an environment in which to train and/or rehabilitate from injury, we need to appreciate the unique qualities of water.

Unique properties of water training

- Water can act to assist, resist, or support (Harelson, 1985)
- Water is approx. 800 x more dense than air (DiPrampero, 1986).
- On land the major force we deal with is gravity. How does that affect workouts? It exposes weaknesses in technique, muscle group imbalances, etc.!

Unique properties of water training

- Water is an "accommodating resistance" = Drag (major variable:V^2 and to a lesser degree CSA)
- No generation of momentum in water like there is on land.

How do these qualities affect workouts and/or rehabilitation protocols?

- HR_{max}(↓10-15 bpm) NOTE: Total cardiac output is the same due to an ↑ SV (44, 124)
- Due to an increase in hydrostatic pressure, especially on the lower extremities, there is an increase in blood flow toward the head. This is assisted by the absence of gravity as well. In turn, this accounts for the lower H_{Rmax} values exhibited in deep water running.
- Another explanation for ↓ HR_{max} is the lower water temperature found in most recreational pools (25.6°-27.8 ° C) McArdle, Magel, Lesmes,&Pechar, 1976)

How do these qualities affect workouts and/or rehabilitation protocols?

- VO_{2max} (↓6 $mlO_2 \cdot kg \cdot min$)
- RPE: ↑1-3 points on the Borg's 6-20 scale. The higher RPE values may be somewhat explained by lesser-trained muscle groups and fiber types being innervated with an ↑in carbohydrate metabolism (Michaud et al, 1995)

How do these qualities affect workouts and/or rehabilitation protocols?

- Important note: At sub-maximal levels (60-65% of VO_{2max}) = no statistically significant difference in HR found (Killgore, et al, 2006; Mercer & Jensen, 1988)
- At sub-maximal levels my research has also shown no statistical difference ($p < .05$) relative to caloric expenditure between land-based and DWR; Women = approx. 8 kcal/min and Men = approx.12 kcal/min (2003)

Other water training factors to consider

- Buoyancy and where on the body it is placed can have HUGE effects on the ability to maintain proper form. Buoyancy belts, etc. Helpful hints: wear close to your COM, "cinch it up", etc. More later……
- Depth of water: a) waist depth = approx. 1/2 of BW supported, b) chest depth = 70-80%, c) deep-water (up to chin w/ buoyant device) = approx. 90%

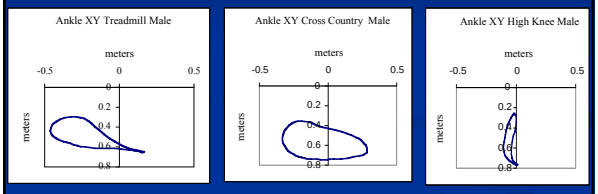
Water Training factors

- The specificity of training principle suggests that the gait pattern of running in deep water needs to be closely aligned with terrestrial running to maximize the benefit to the runner (15).
- Running Style differences, especially in deep-water running (HK vs.Cross-Country or "Open Gait"; Killgore, et al, 2006)

Deep Water Running Study

- Comparison of deep water running styles: Cross Country or "Open" Gait vs. stereotypical gait (HK), both shod and barefoot
- 20 NCAA III runners @ 60-65% of land-based VO_{2max} @ steady state
- Published in JSCR (2006), 20 (4), 919-927

Water Training Factors: Style



Water Training Factors: Style

QuickTime™ and a
Microsoft Video 1 decompressor
are needed to see this picture.

Water Training Factors: Style (proper technique summary)

1. Head held in neutral
2. Body has a slight forward lean - think running into a headwind
3. Arms swing from the shoulders with elbows held at 90° and hands in a slightly clenched fist
4. Knee up, toe up leg position with a "footstrike" on the bottom of the pool
5. Maintain appropriate ROM throughout the gait cycle to maximize the runner's effective SL on land.

Proper Form

QuickTime™ and a
DV/DVCPRO - NTSC decompressor
are needed to see this picture.

DWR
Skill level

- It has been reported that lesser skilled runners in deep water exhibit higher heart rates for a given VO_2 (Dowzer, et al, 1998).
- The skill or experience of the runner while DWR is important to proper mechanics as well!
- Experience of the person in the water, e.g. Have they trained hard in the water before? How "comfortable" are they in this environment?

DWR: Stride rates

- The HK style's SR is typically approx. 90% of that found on land, but with a VERY limited ROM.
- If you want to maximize your gains back to land-based running, DO NOT use any of the published cadence charts. They are based on the HK style of DWR.
- The "open gait" or CC style is approx. 60-65%, but has a ROM that is more similar to that found on land. This also innervates more of the muscles in the legs…where it belongs, and less in the upper body!

Why wear shoes in water training?

My contention is that running in shoes while in deep water, even though the foot never touches the bottom of the pool, may provide more neuromuscular feedback via the shoe and increase the runner's sensation of terrestrial running.

Why wear shoes in water training?

- This contention is perhaps corroborated by Nurse and Nigg (2001) who found that changes in muscle activity on the plantar surface of the foot are associated with the amount of sensation.

Why wear shoes in water training?

- In addition to the possible increase in the neuromuscular feedback, the shoe will also increase the amount of work the runner experiences.
- Martin (1985) demonstrated that wearing shoes while running on land increases the load on the lower extremity, thereby increasing the oxygen consumption and heart rate.

Why wear shoes in water training?

- Martin further pointed out that other studies have consistently shown an approximate increase in energy costs of roughly 5-10% when shoes are added to the feet.

Why wear shoes in water training?

- Additionally, in a post-testing Likert Scale of 1-5 with 5 = Very Strongly Agree, SCC was rated the highest to feel most like land-based running (4.2; BCC = 3.8, SHK = 2.3, BHK = 2) (Killgore, et al 2003)
- And again in a recent study (2008) with SCC being rated a 4.4 on a similar scale vs. 2.4 for barefoot only

Why wear shoes in water training?

While exercising in shallow water shoes can provide better support and traction on slippery surfaces and the bottom of the pool.
(Hamer and Morton, 1997)

The shoes can also provide more resistance.

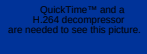
AQx Aquatic Training Shoes

- AQx has developed a shoe specifically designed to take advantage of the accommodating resistance of the water.
- Our testing revealed that The "Aquatic Training Shoe" provides 20-30% more resistance at a medium pace than a normal running shoe or a bare foot while running in deep water.

AQx Aquatic Training Shoes

- The amount of resistance may seem somewhat subtle; you must remember the cumulative effect over time.
- This is not that dissimilar from wearing racing shoes that are slightly lighter so as to decrease the metabolic cost (except we're working the opposite end of the spectrum to provide a slight increase to the metabolic cost). (think Bowermen's experiments!)

AQx Aquatic Training Shoes



AQx Aquatic Training shoes difference

- Total HR difference = ↑6.5 bpm
- Total RPE difference = ↑ 2.2
- while wearing the shoes during hard intervals
- NOTE: These values are associated MORE with the actual leg muscles used during running rather than an over-emphasis on the upper body!

AQx Aquatic Training shoes difference

- A recent (Fall, 2007) study was conducted at Brigham Young University using the shoes on an underwater Treadmill (HydroWorx)
- The results indicated that wearing the shoes allowed the runner to achieve the same CV (HR) effect at a slower pace (difference = 1.5 MPH)

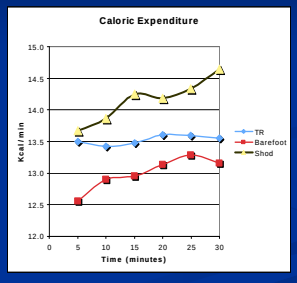
Most recent Aquatic Training shoe scientific research

- Just completed data collection and analysis on 8 male NCAA III championship caliber distance and mid-distance runners
- All subjects had a minimum of 6 months of experience with running in the water correctly with shoes on
- Mean descriptive data: age = 20.5 yrs. (±1.4); Ht = 178.9 cm (±4.8); Wt = 66.8 (±6.0); BF% = 8.3 (±2.4); VO_{2max} $mlO_2 \cdot k \cdot min$ = 64.8 (±2.7)

Most recent Aquatic Training shoe scientific research

- The results indicated statistically significant ($p \leq .05$) findings for caloric expenditure, VO_2, RPE, RER, and SR
- Statistical Non-significant variable was HR ($p = .105$)

Take-home: ATS = ↑ 9% kcal



AQx Aquatic Training shoes: other uses

- The sole is made of a sticky rubber to increase the coefficient of friction which helps with traction on slippery pool bottoms, showers, etc.
- This type of sole has enhanced running form drills, plyometrics, and/or agility drills, etc., while the increased resistance via the fins increases the workload

Anecdotal Evidence

- The AQx Aquatic training shoes have been used by several elite and collegiate running programs, as well as many professional athletes in all sports, with very good results.
- Additionally, Lornah Kiplagat set WR's for the 10 mile and 20km about 1 week apart while using our shoes for a "slight injury". She trains in them 3-5 x /week for the past 2 years.

Anecdotal Evidence

- The 2006 NCAA CC Champion wore our shoes to train on an underwater treadmill while recovering from a long-term injury prior to winning his title.

Anecdotal Evidence

- One of my female steeplechasers was 4th at the NCAA III T&F championships and set the all-time conference record, while training 30-40 % of the time in the water
- One of my sprinter's was the NWC "Athlete of the Year" last year and won the 100m, 200m, and 4 x 100 relay…after straining a hamstring early and recovering in the water.

AQx….What's new?

- Zero Gravity suit was designed specifically for runners to provide the best possible running position in the water.
- Rationale: Provides better overall comfort, PROPER buoyancy distribution, thermal barrier, additional resistance, increased flexibility of workout routines, etc.

AQx Zero Gravity Buoyancy Suit/ATS

Training General Rules of Thumb

- For aerobic type running in the deep-water = a SR of approx. 60-65% of land-based SR, e.g. ON land SR of 82 = DWR SR of 49-53
- This type of running is appropriate for "morning" runs, recovery days, etc.
- Harder efforts require SR's of anywhere from 70-90% of land

Training General Rules of Thumb

- The same type of training you can do on land can be done in water, but you will need to build up the workloads…just like on land.
- This is due to the exposure of weaker muscles and groups of muscles by moving in a much more viscous environment.
- Do NOT assume that you can accomplish the exact same thing in the water without a logical progression of activity in the water!

Training General Rules of Thumb

- Examples of workout ideas are to combine land-based and water training , e.g. a 20 minute "tempo" run, followed by 5 x 1 min hard w/ 1 min off in the deep water.
- 5, 4, 3, 2 ,1 w/ upcoming, etc.
- 6-8 x 2:30 on w/ 1:30 off, etc.

Training General Rules of Thumb

- Always try to finish in the deep-water with the nice "open gait" pattern. This will aid recovery and stretch muscles back out, especially after hard intervals, long runs, weight training or plyometric workouts, etc.
- Recovery running in the pool is WAY underrated! (Reilly & Ekblom, 2005)

Injury Prevention/Rehab

- The addition of quality water training to any program can lead to a decrease in the incidence rate of injuries, as well as, increase strength, power, dynamic flexibility, coordination, endurance, etc.
- Balance within a program.

Injury Prevention/Rehab

- We need to stay ahead of the curve by consistently training in the pool to maximize what we get out of these sessions!
- Please keep in mind that it takes awhile to have the **correct technique**, let alone train efficiently in the water. This is no different than wts., plyo's, intervals, etc. (adaptation)

More information

- Classes and training are currently being offered at Nike's World Headquarters in the Lance Armstrong Pool!!

More Information

- Please see our website:

  www.aqxsports.com

  intelligent training: just add water™

  - Or email me at gkillgor@linfield.edu for specific ideas of workouts, etc.
    - Training clinics are available.

Testimonial

- "My runners have used the AQx deepwater running shoe for both deepwater running and running on the underwater treadmill. I like the shoe for deepwater running as it provides extra resistance and helps keep the runners in more of a natural running position. The shoe is also great for running on the underwater treadmill as it protects the bottom of the foot and adds cushioning for those runners recovering from overuse injuries".
- Ed Eyestone, Head Men's CC and Asst. T&F coach, BYU