Making Waves: Exploring Opportunities with Aquatic Rehabilitation

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Disclosures

- Paid by SwimEx to create web content and provide in-service training using their pools. My travel and housing for this conference were paid by SwimEx.
- Individuals in the photos and videos are not patients and have consented to the use of their images in this and other presentations.

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Goals

- Review the properties of water and how those properties impact aquatic rehabilitation sessions.
- Present a progression of exercises for lower extremity injuries
- Review 6 research studies looking at aquatic rehabilitation compared to land based rehabilitation.

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Safety first

- Never swim alone, never leave patients alone – always have a lifeguard or at least another individual watching
- Floatation devices are safety devices, not lifesaving devices

- Cautions: Fear of the water, medications which cause dizziness and alter blood pressure or heart rate, ear infections, cardiac conditions, controlled seizure disorders

- ABSOLUTE contra-indications: open wounds, acute illnesses/infections, uncontrolled seizure disorders

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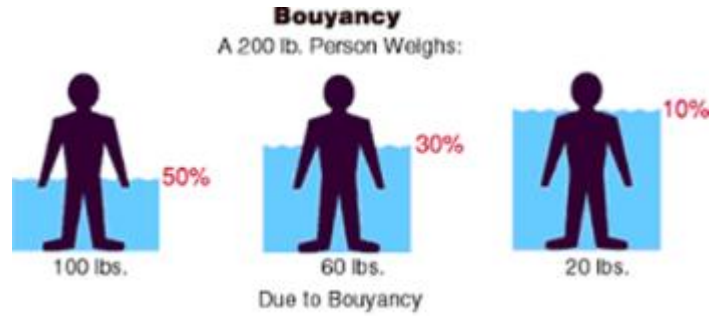
Properties of Water

- Buoyancy and Specific Gravity :
  - Archimedes Principle: A body submerged in water will experience an upward force equal to the weight of the water displaced….also known as buoyancy
  - Objects with specific gravity (density) less than that of fresh water (=1) will float
  - Humans generally have specific gravity slightly less than that of water (.98). Humans also have balloons in their chest (lungs), fill them with air, and they will float.
  - Relative density of a body depends on its composition.
    - Specific gravity of fat=.8, Specific gravity of bone=1.8, Specific gravity of muscle=1.1
    - What does this mean? Lean people tend to sink, fatter people float
- APPLICATION:
  - Waist deep = ~50% weight bearing
  - Chest deep = ~30% weight bearing
  - Shoulder deep = ~10% weight bearing



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Properties of Water

- Hydrostatic Pressure (Compression):
  - When you submerge an object in water, the pressure is exerted equally on all parts of the object and the pressure increases relative to the depth of immersion, approximately 2mm/HG per 1” depth.
  - Immersion to 48” (4 feet – 1.2 meters) creates compressive forces of 88.9mmHG which is slightly higher than diastolic blood pressure and well within recommendations for intermittent compression.
  - Application: Exercise in water = exercise wearing compression sleeve

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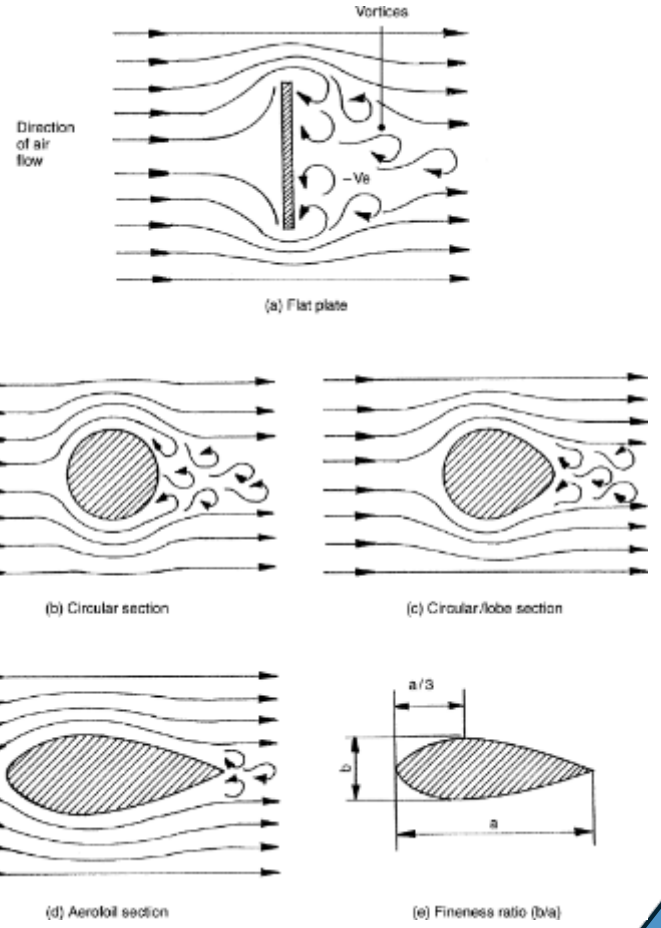
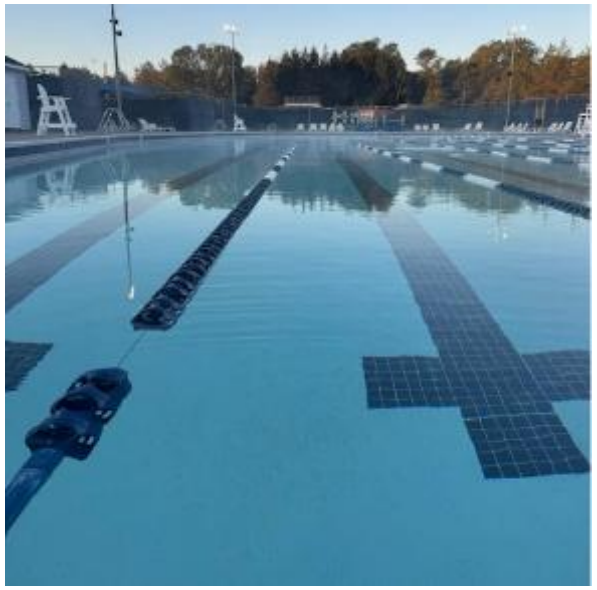
Properties of Water

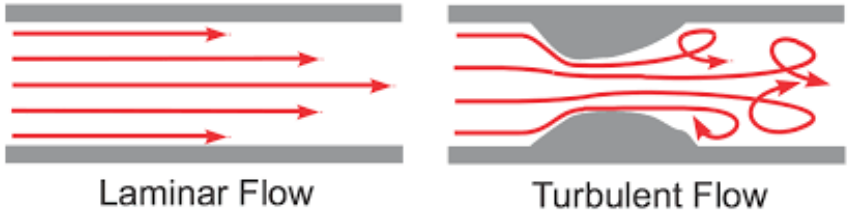
- Viscosity/bow and drag forces (R):
  - Friction from body moving through water must overcome bow forces which, in turn, causes drag forces
  - Analogy: creating a "whirlpool" in a regular pool when you were a kid
  - Size and shape of object impacts these forces (larger = harder)
  - Doubling the speed quadruples the drag (2X faster = 4X harder)
  - Application: Increase surface area and speed of movement to increase resistance



Properties of water

- Turbulence and Laminar Flow can be used to create additional challenges.
  - Turbulence: acts as a perturbation to balance based activities
  - Laminar Flow (Swim Ex): creates additional bow forces (resistance) as an object moves through the water.
  - Laminar Flow can be used to create targeted forces on limbs such as a valgus or varus force on a knee





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Application – Treatment Philosophy

- Using the properties of water, we can decrease weight bearing loads, exercise in a compressive environment, use viscosity, bow forces and laminar flow to increase resistance to movement.
- Many think “alternative to CV fitness”, “stay in shape”, “deep water run”, treadmill run, regular “swimming”
- Compliment to land based activities – not exclusive but supplemental.
- Only limited by your own creativity.

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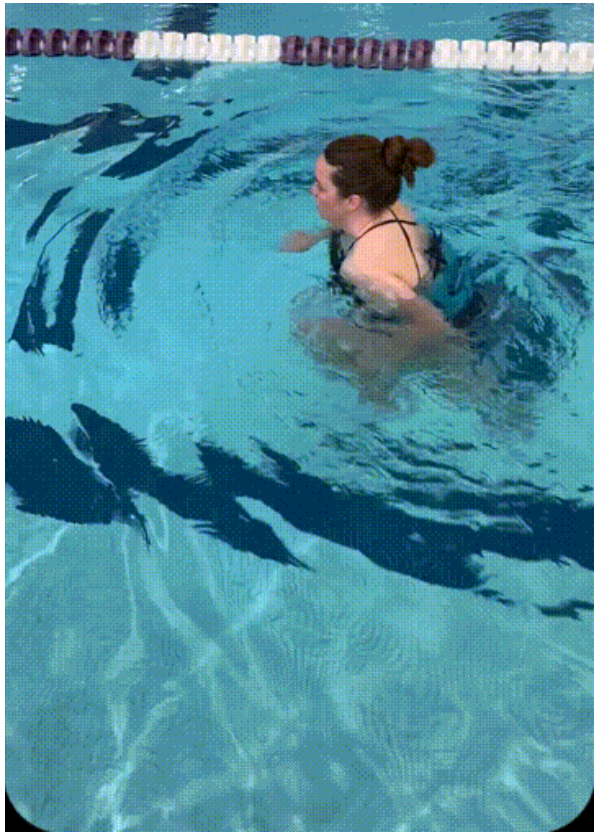
Lower Extremity exercises EARLY

- Deep water running – learned skill
- Walking (forward/backward)
- Marching (forward/backward)
- SL balance
- Flutter kicking (progression)
  - Wall, kickboard, add fins, vertical
  - Ankle PF, knee extension
- Squats
  - DL progress to SL
  - Add a push and pull with dumbbell
- Step-ups (forward/lateral)



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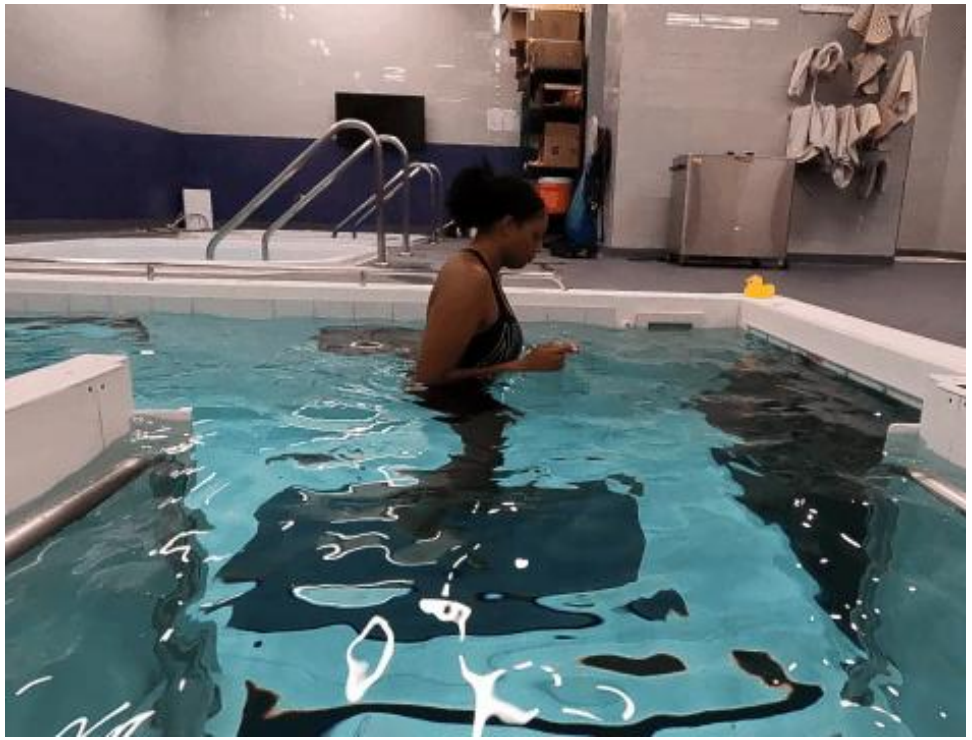

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Lower Extremity EARLY

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- SL balance (use flow to modify)
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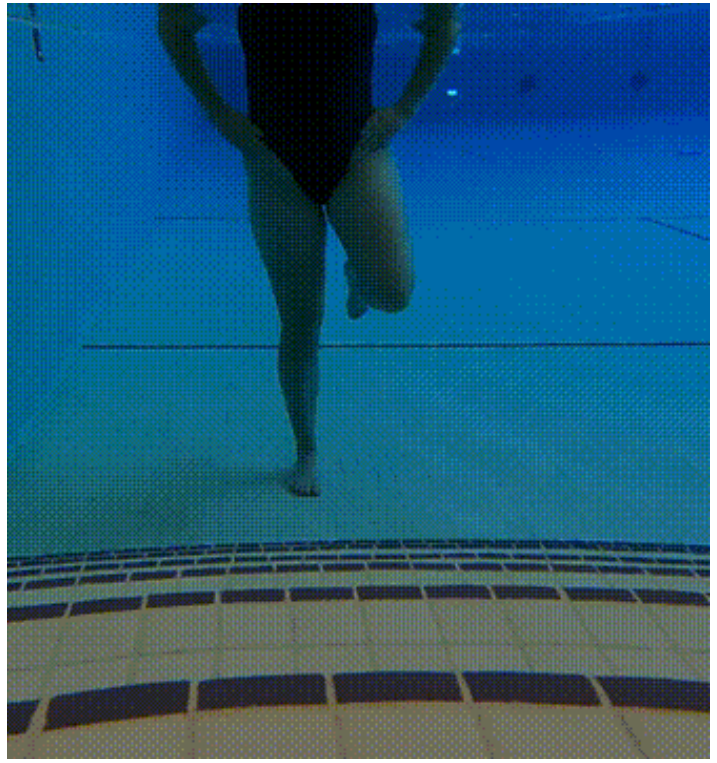

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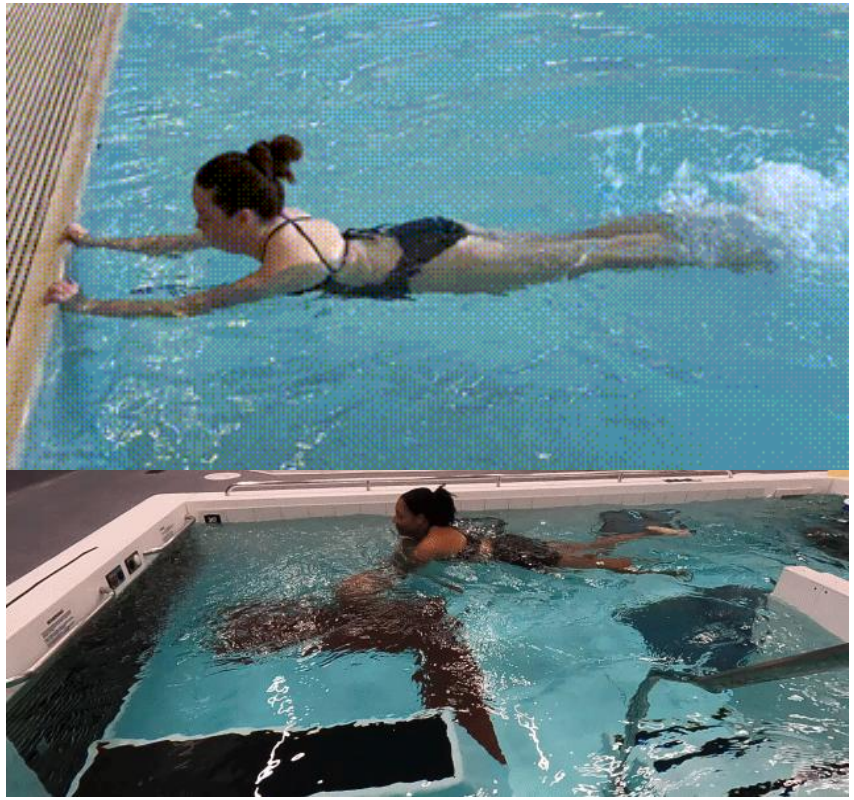

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  - Ankle PF, knee extension
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  - DL progress to SL
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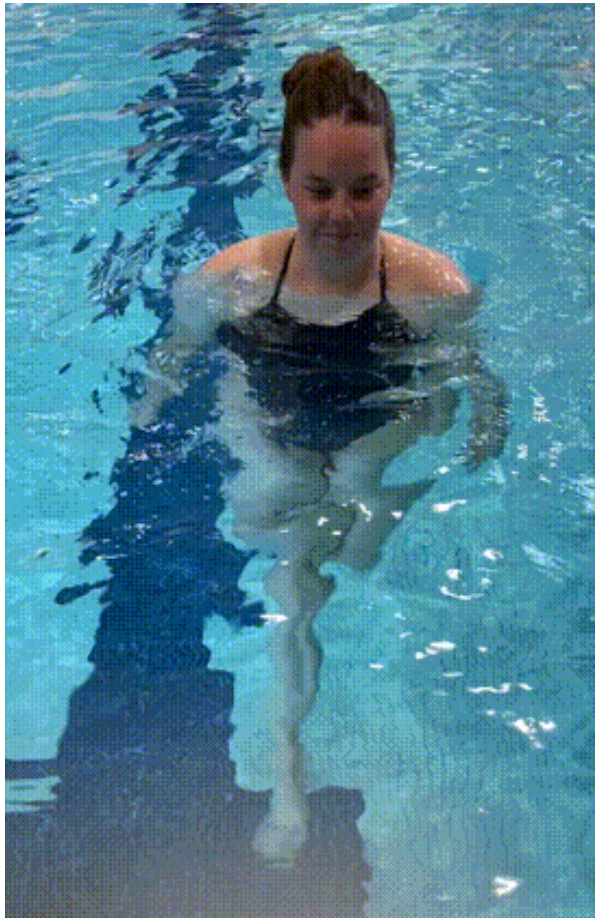

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Lower Extremity MIDDLE

- Lateral walking
  - progress to shuffle
- Skipping
- Quick feet
- Lateral line hops
  - DL progress to SL
- Run on slanted pad
- Lateral hops on pads
- Hamstring curls, in standing

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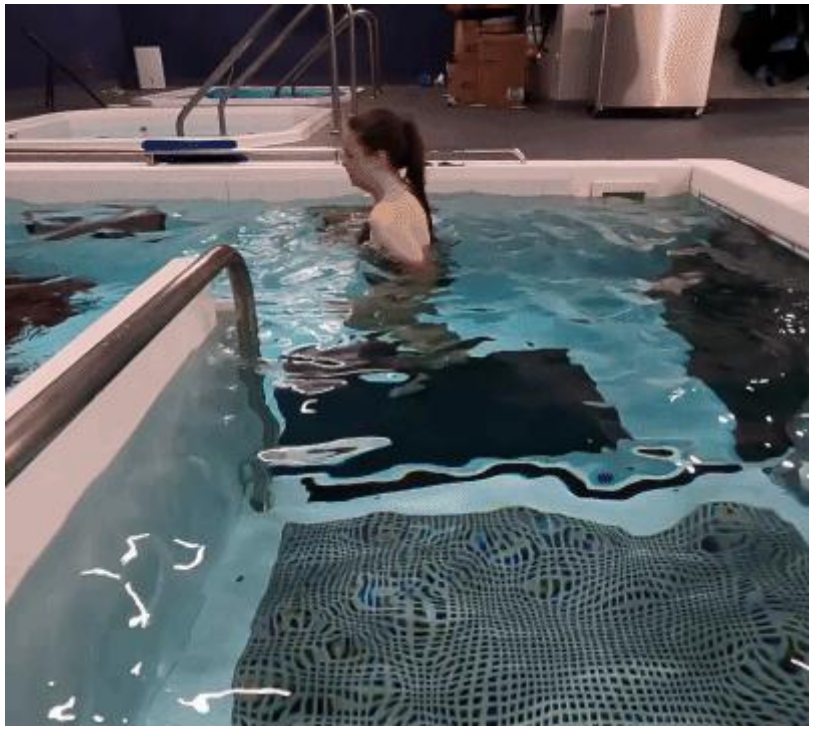

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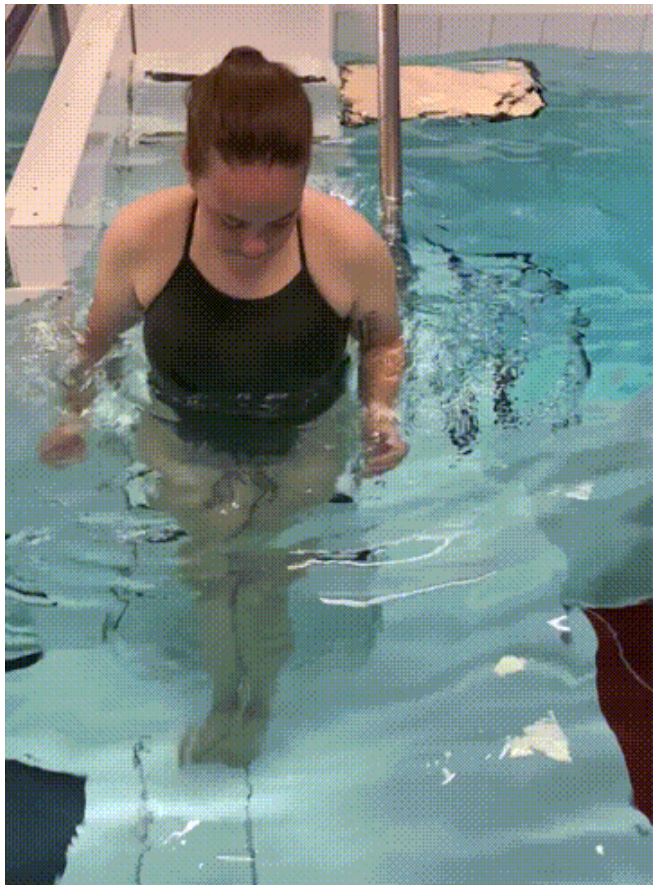

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Lower Extremity LATE

- Single leg hop to stabilization
  - Forward
  - Lateral
- Repeated lateral hops
- Tuck jumps
- Backboard touches/volleyball touches
- Jump to grab ball, pivot (Swim Ex)

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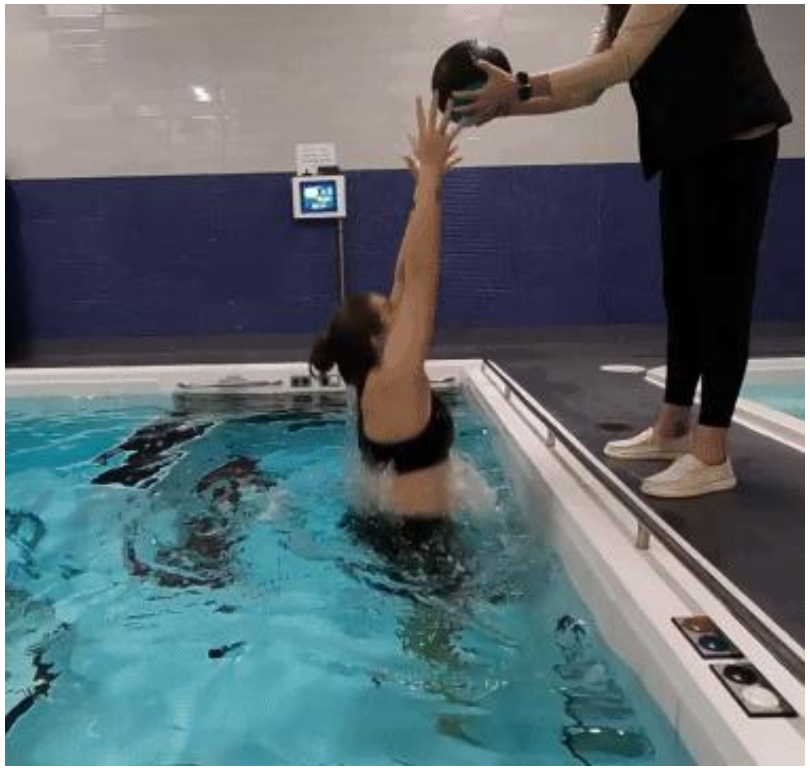
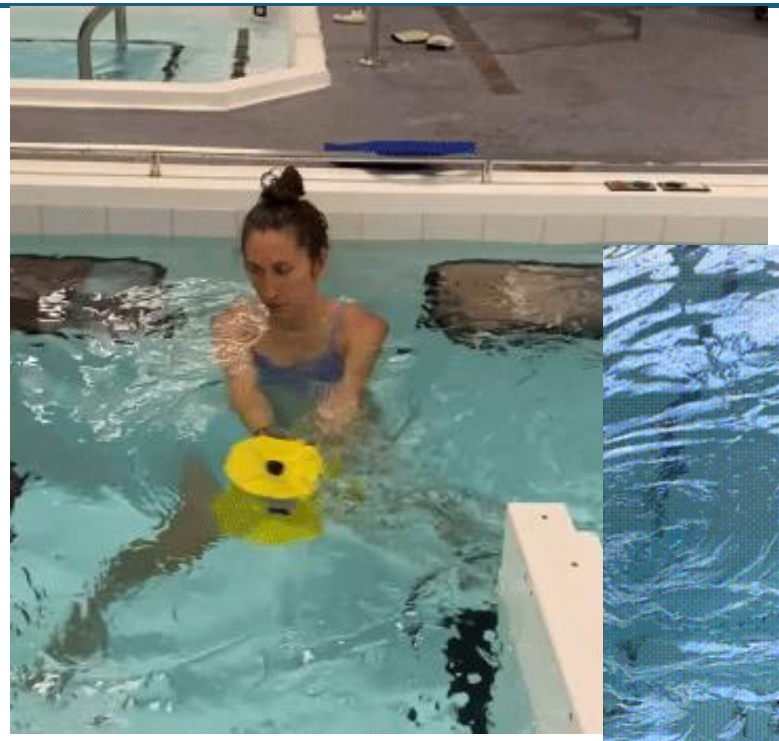
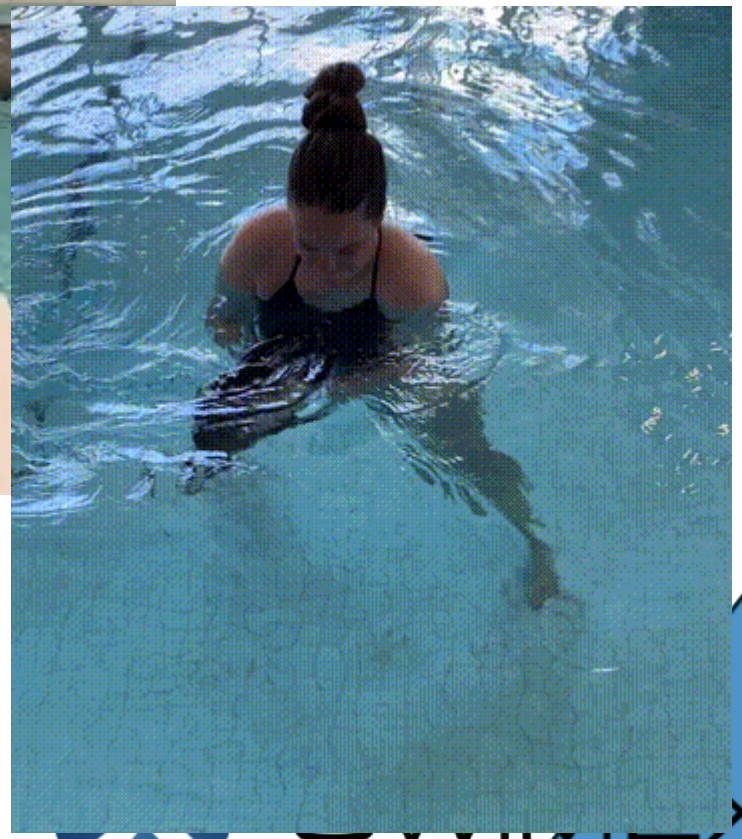


Core activities

- Stabilization
  - ALL balance
  - ALL shoulder stabilization
  - Vertical kicking
- Rotation
  - Hands, dumbbell, kickboard
  - Ball figure 8s
- Anti-rotation





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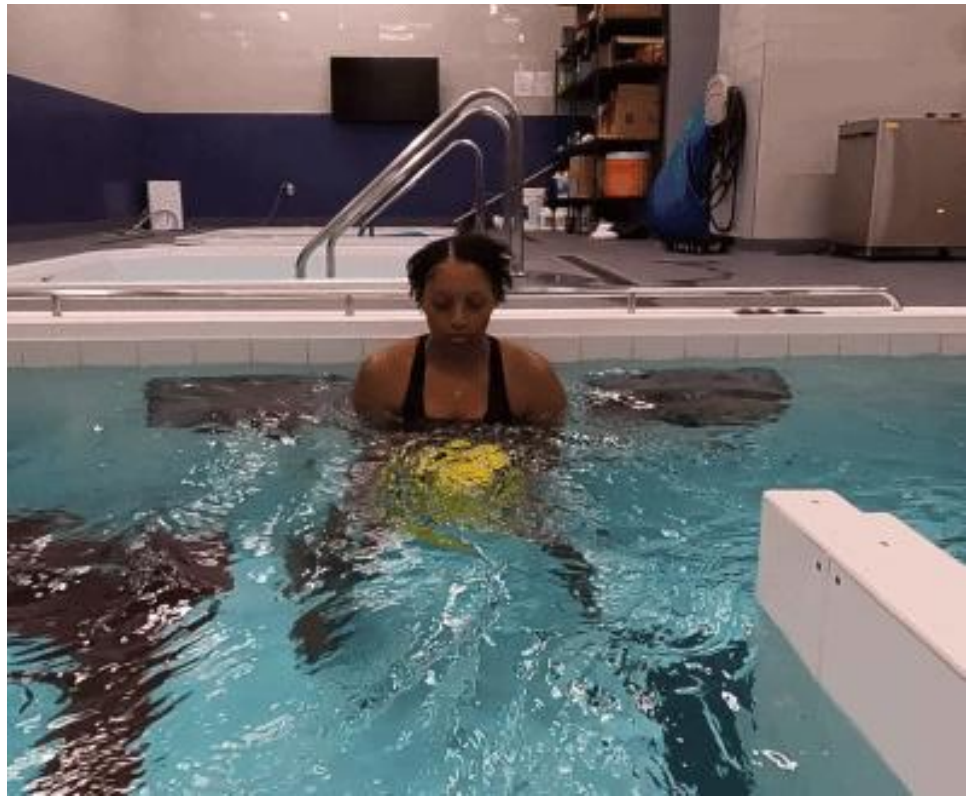

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What does research support?

- Well controlled studies difficult to design
- Small sample size
- Patient population often older, non-athletic
- Plenty of opportunities for projects!

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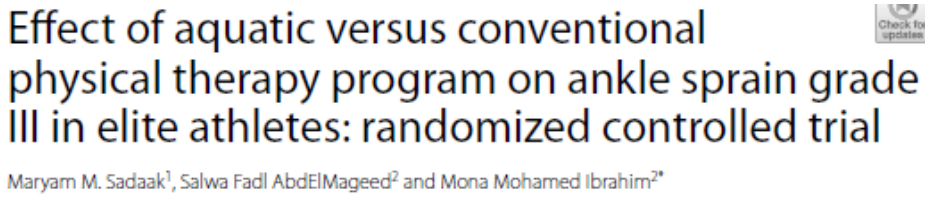
Research: Ankle Injuries

- 30 College students with unilateral CAI
  - Split into two groups, aquatic and land
  - Performed same 20 min protocol, 5 exercises on 2 surfaces, 3x/week for 6 weeks
  - Static and dynamic balance assessments pre-post with Biodex Balance Platform
  - BOTH land and aquatic groups improved, but no difference between groups

Foot Ankle Spec. 2013;6(5):346-351



- 30 Elite Athletes with GR III ankle sprains
  - First 4 weeks split into land and aquatic groups
  - Assessed Pain (VAS), Dynamic Balance (SEBT), Function (hop tests), Agility (T-test and Illinois test), strength (leg press) and time to RTP
  - Aquatic group RTP at 4.7 weeks and land at 7.7
  - Aquatic reported less pain and outperformed land based group on most all assessments at 4 weeks

J Orthop Surg Res. 2024 Jul 11;19(1):400

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Research: ACL

Effects of Innovative Aquatic Proprioceptive Training on Knee Proprioception in Athletes with Anterior Cruciate Ligament Reconstruction: A Randomized Controlled Trial

Elie Hajouj, PT, MSc[1]; Mohammad Reza Hadian, PT, PhD[1,2]; Seyed Mohsen Mir, PT, PhD[1]; Saeed Talebian, PT, PhD[1], Salah Ghazi, PT, MSc[1]

Research performed at Tehran University of Medical Sciences, Tehran, Iran

- 38 male athletes, traditional ACLR rehab
  - During weeks 7-12, half added aquatic proprioception training to land rehab protocol
  - Aquatic balance training on a foam roller
  - Joint position sense improved and pain was lower in aquatic group when compared to land only group

Arch Bone Jt Surg. 2021;9(5):519-526

Effects of Aquatic Therapy on Gait Symmetry and Muscle Properties Following Anterior Cruciate Ligament Reconstruction: A Pilot Randomized Controlled Trial

- 20 post-op ACL patients
  - At 7 weeks, half performed 6X70 min aquatic program over next 2 weeks, while rest continued with land program
  - Assessed gait symmetry, muscle tone and stiffness pre-post aquatic intervention.
  - Step length symmetry for aquatic group post intervention was 99.59% (4.74% improvement) while land group was 93.26%.
  - All other assessments showed similar gains between the aquatic and land groups.

J Sport Rehabil. 2025 Jul 23:1-10

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Research: Plyometrics

THE EFFECTS OF LAND VS. AQUATIC PLYOMETRICS ON POWER, TORQUE, VELOCITY, AND MUSCLE SORENESS IN WOMEN

LEAH E. ROBINSON,[1] STEVEN T. DEVOR,[1] MARK A. MERRICK,[2] AND JANET BUCKWORTH[1]

- 32 physically active young women – 2 grps
  - 8 week identical plyometric program, 3X/week, one in water, one on land,
  - Regardless of training group, there was increase in peak VJ and isometric peak torque
  - Aquatic training group reported less muscle soreness (48 and 96 hours post), especially as program intensity increased
  - Land training group also had more pain sensitivity post training

J Strength Cond Res. 2004;18(1):84-91

The Impact of Aquatic Based Plyometric Training on Jump Performance: A Critical Review

PRYSE M. MULLENAX†, QUINCY R. JOHNSON†, MICHAEL A. TREVINO‡, DOUGLAS B. SMITH‡, BERT H. JACOBSON‡, and J. JAY DAWES‡1

- 8 studies using ATHLETE subjects
  - Plyometric training ranged 6-12 weeks and all land programs were the same as aquatic programs
  - Many studies found APT groups showed greater VJ improvement than LPT
  - 7 of 8 found APT gains similar to LPT on all variables measured
  - Suggest aquatic plyometric as suitable alternative to land with decreased injury risk

Int J Exerc Sci. 2021;14(6):815-828

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Research Summary

- Balance improvements are comparable to land based training[1]
- Acute Gr III ankle sprains RTP 3 weeks faster[2]
- ACL patients improved gait symmetry[3] and had better joint position sense[4]
- Aquatic Plyometric training result in similar increases in jump measures (VJ, leg power, isometric strength gains) to when performed on land, but with decrease muscle soreness and less sensitivity to pain[5,6]
- Clinical bottom line: significant gains in numerous rehabilitation parameters in addition to CV fitness
  - Can begin earlier in rehabilitation with less risk of injury
  - Anecdotally, patients enjoy the change of environment and gain confidence as they transition to FUNctional activities

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SUMMARY and QUESTIONS

Understand the principles of water and use your creativity

What you do on land can be supplemented and recreated in water

New ideas? Other ideas?

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