High Intensity aerobic Aquatic Exercise in the management of lower limb OA and post arthroplasty

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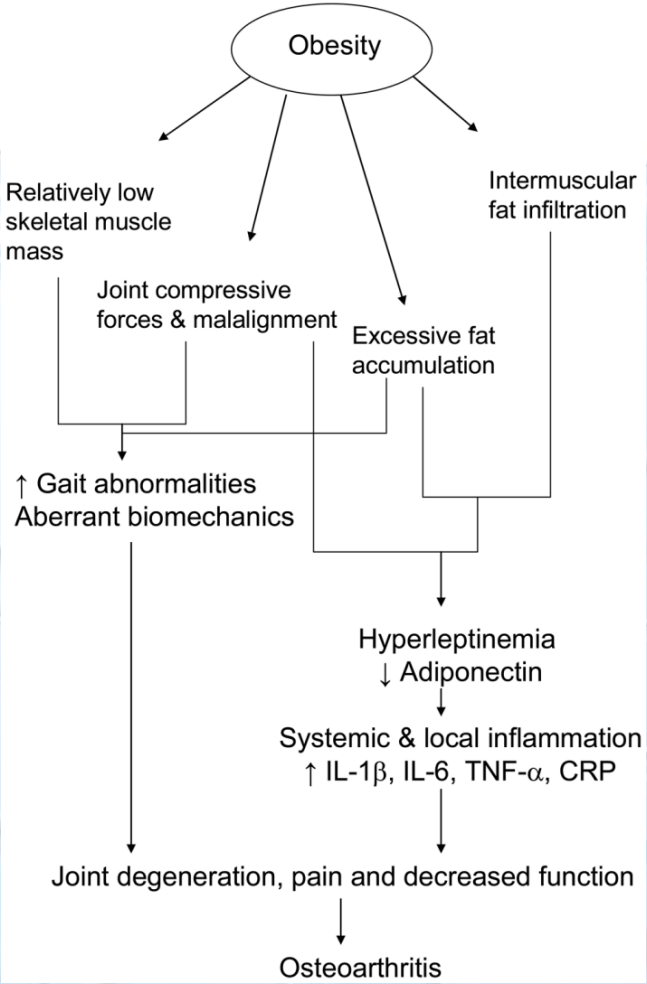
Obesity and OA

Osteoarthritis (OA) and obesity are intrinsically linked through both inflammatory mechanisms and sub-optimal biomechanical loading of the cartilage



Vincent et al, PM R 2012

Role of obesity on risk and progression of lower limb OA

- Obesity is related to a faster progression of symptoms (Nebel et al 2009)
- For every 5Kg (2 BMI points) the risk of developing OA increases 36% (Lementowski and Zelicof 2008)
- Mechanisms include:
  - Relative loss of muscle mass and strength over time
  - Mechanical stress
  - Systematic inflammation

Benefits of aerobic training in the management of OA

- Aerobic exercise effective at decreasing pain and improving function in people with lower limb OA (Roddy et al 2005)
- Christensen et al (Ann rheum dis 2007) in their systematic review indicated a loss of at least 10% of body weight is associated with medium to large improvements in joint pain
- Exercise combined with diet is more effective than exercise alone in this population (Messiers et al 2000, 2004, 2013).
- Aquatic exercise is generally recommended for this patient group as it is easier to attain suitable intensities for aerobic exercise.

High Intensity Interval Training

- HIIT involves repeatedly exercising at a high intensity (>90% intensity) for 30 sec-several minutes with 1-5 minutes of low/no intensity rest period (Gibola & McGee 2008)
- HIIT results in increased exercise energy expenditure (during and post intervention)
- Evidence suggests HIIT could be superior than continuous moderate exercise (although conflicting data exists) for:
  - ↓total and HDL cholesterol
  - ↓BMI and body fat content
  - ↑VO2 max
  - ↓Blood pressure
- Land based HIIT is associated with an increase in musculoskeletal injuries which could be reduced in water

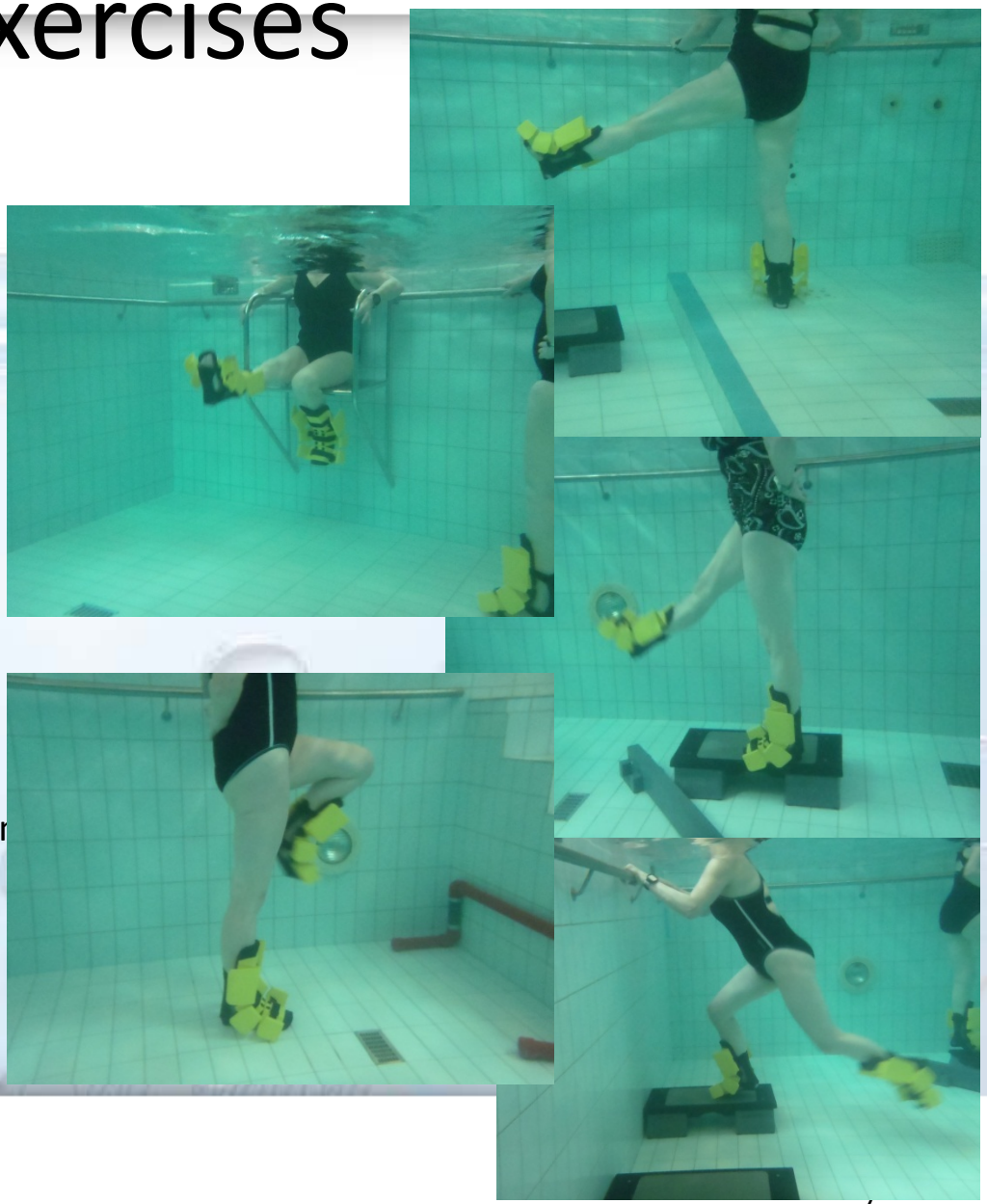
Aquatic Exercises

- 16 weeks
- 3 x 1 hours training sessions per week
- 30 minutes of high intensive interval training per session

30-45 seconds per leg plus 30-45 seconds rest

AS HARD AND FAST AS POSSIBLE

1. Hip adduction/abduction
2. Seated knee flexion/extension
3. Standing knee flexion/extension
4. Hip flexion/extension with knee remaining in full extension
5. Kickback (reverse lunge)



Training Program and Structure

16 weeks

3 x 1 hours training sessions per week

30 minutes of high intensive interval training per session

Weeks	Resistance Type	Sets	Reps	Time (sec)	Recovery (sec)	BORG	Total time (mins)	Total No. reps
1-2	Barefoot	3	25-30	45	30	14-15	30	750-900
3-5	Small	3	20-25	45	30	15-16	30	600-750
			12 to 15	30	45		26	288-360
6-8 and 12	Small/Large	3	14-20	45	30	16-17	30	420-600
9-11 and 13-16	Large	3	14-20	45	30	16-18	30	420-600
			12 to 15	30	45		26	288-360

Measuring training intensity

- Every session:
  - Perceived rate of exertion (Borg 6-20)
  - Average and maximum heart rates (Polar) for whole session
  - Knee pain (VAS 0-100mm)

- Additional measurements during sessions no. 34, 35, 36:
  - Capillary blood Lactates
  - Repetitions per movement per leg

Biophysical repsonse to Aquatic training compared to land (Denning et al 2012)

- VO2 consumption
  - 10-27% lower in Deep Water (DW) running
  - 10-16% lower in Shallow Water running
  - Conflicting data for water calisthenics, difficult to control
  - Conflicting also for underwater treadmill, dependent of depth, speed and water jet strength, easiest to control
- Heart Rate
  - 15% lower in DW running than land based running
  - SW produces higher HR compared to DW
  - Conflicting data for water calisthenics, difficult to control
  - When set at similar levels of V02 consumption HR during underwater treadmill running HR is comparable to land.
- Rating of Perceived exertion
  - At maximal effort RPE is similar during DW than land, at set levels of HR RPE was higher during DW
  - Limited data for water calisthenics
  - RPE higher at set levels of V02 max during underwater treadmill running although dependent on depth.
- Blood lactates
  - Similar, lower or similar when comparing maximal VO2 effort to DW running (Brennan & Wilder 2011)
  - Blood Lactates similar post maximal effort on underwater treadmill (Silvers et al 2007)

Bressel et al 2014

High-Intensity Interval Training on an Aquatic Treadmill in Adults With Osteoarthritis: Effect on Pain, Balance, Function, and Mobility

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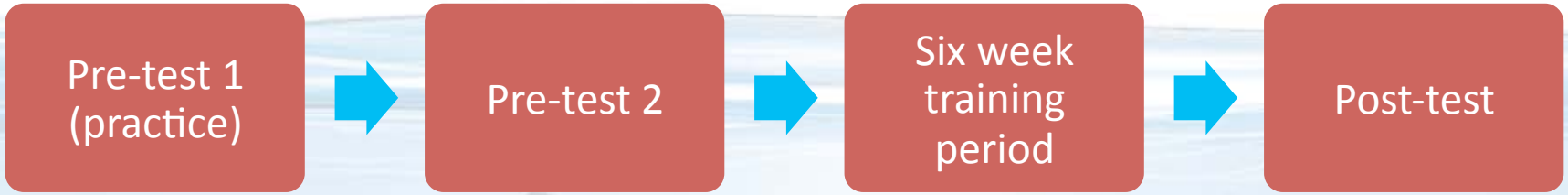
Methods

- Patients diagnosed with osteoarthitis
  - n = 18
  - Age = 64.5 ± 10.2 yrs.
  - Body mass = 79.7 ± 11.6 kg
  - Involved limb = 1 or both knees = 100%, knee and hip = 42%
  - Duration of arthritis = 6.8 ± 11.6 yrs

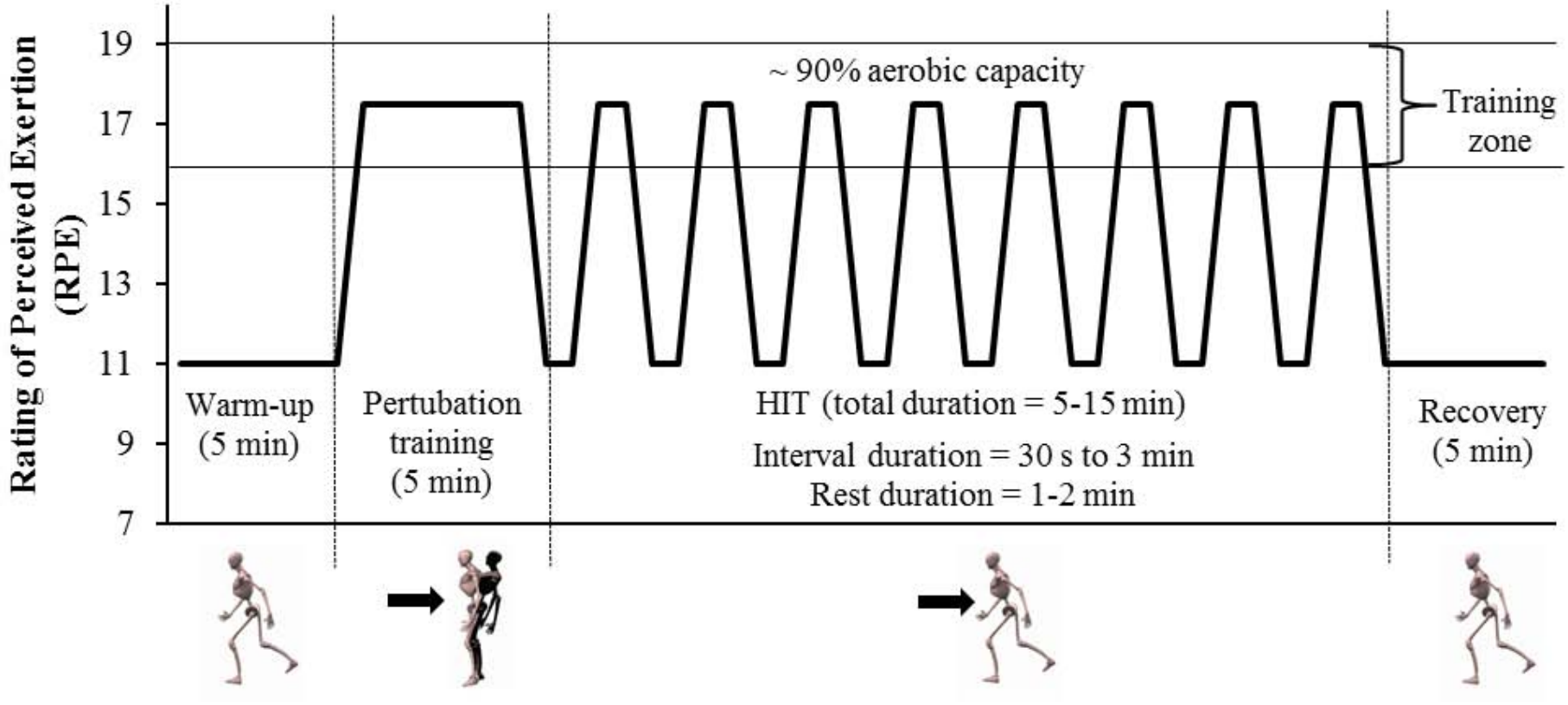
Structure of study



Key features of training program

Applies interval training concept (HIT)
Walking on an underwater treadmill
Applies balance specific training with jets

Intervention



Protocol

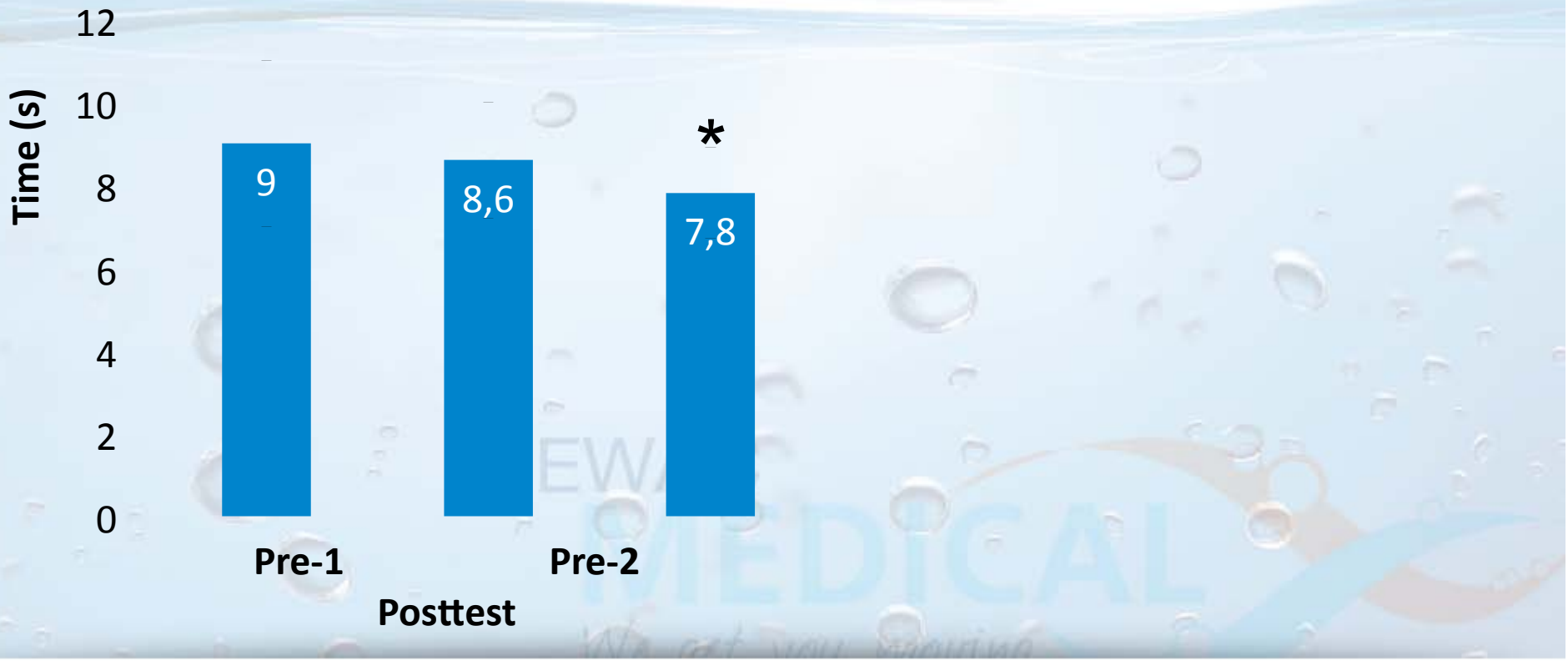
TABLE 2. Aquatic treadmill exercise protocol progression.*†

Week	Frequency and duration (min) of exercise	Warm-up/ recovery speed ($m \cdot s^{-1}$) and RPE	Interval speed and recovery speed ($m \cdot s^{-1}$)	Interval jet intensity (%)	Interval frequency, duration, and rest duration (min)	Interval RPE and rest RPE	Balance RPE and jet intensity (%)
1	2/18	1.3/10	1.3/1.3	50	3/0.5/1	13/10	11/53
2	2/20	1.5/10	1.5/1.5	56	4/0.8/1	14/10	13/58
3	2/20	1.6/10	1.7/1.6	63	4/1.5/1.5	16/10	13/63
4	2/30	1.6/10	1.8/1.6	69	4/2.5/2.5	17/10	15/67
5	3/30	1.7/10	2.0/1.7	75	6/1.3/1.3	18/10	17/70
6	3/30	1.8/10	2.1/1.8	80	6/1.2/1.2	19/10	18/74

*RPE = rating of perceived exertion.
†Values are means for all subjects.

10-M Walk Test

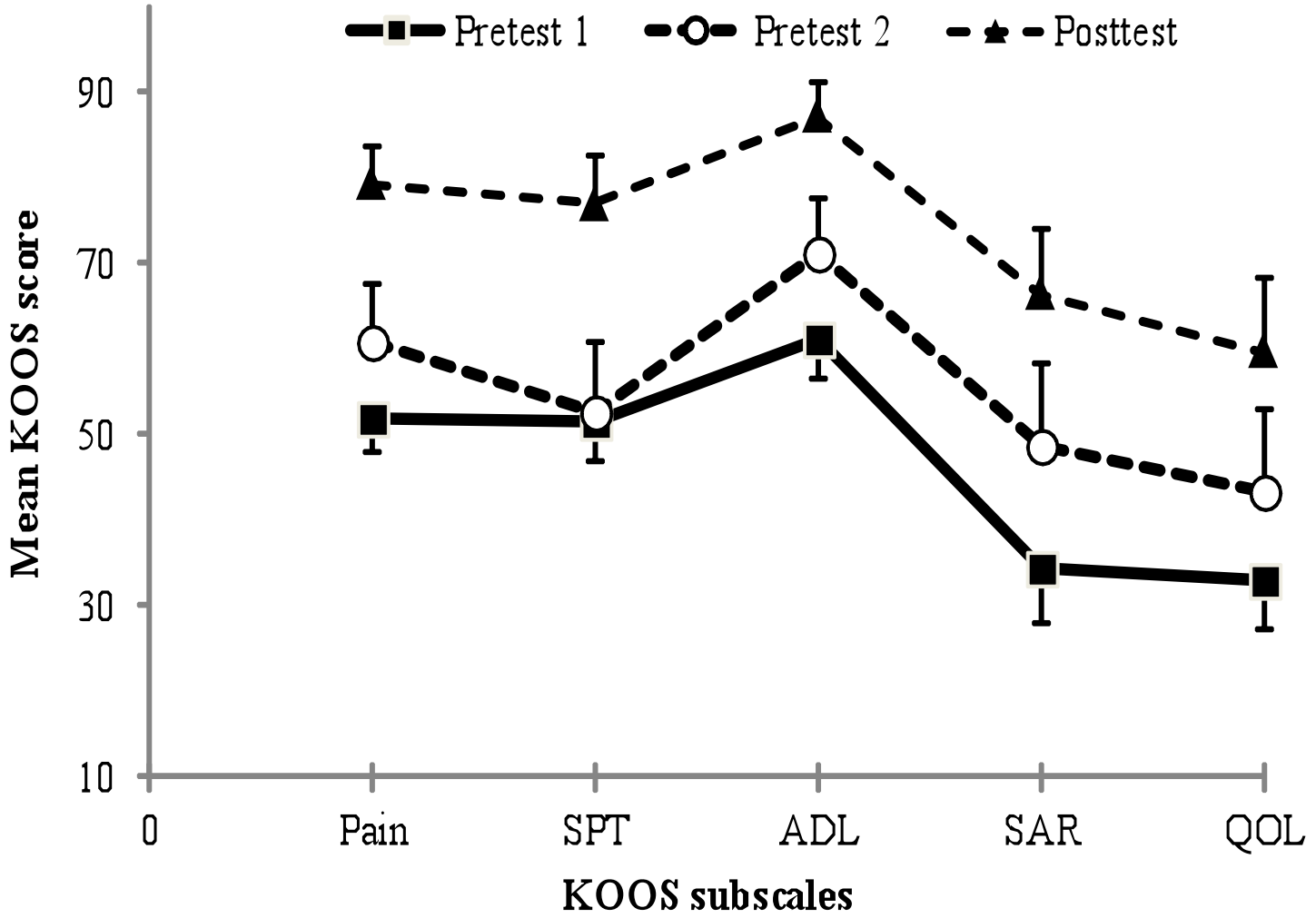
ES = 0.58; *p* = 0.01



Walk time: Time to cover 10-m using preferred pace

Normative values = 9.3 s

KOOS Scores



100 indicates no problems and 0 indicates extreme problems

Conclusions

- Select balance, pain, and functional measurements tend to improve after 6 weeks of aquatic interval training.
- The interval training protocol was well tolerated. All participants raved about the protocol and desire to keep training in the pool.

Practical session

- Different ways to perform HIIT in the pool:
  - 20 minutes of gradually alternating 1 minute work and 1 minute rest using
    - Aquatic treadmill
    - Aquatic bike
    - Lower limb resistance boots
    - Teathered aquajogging
- Comparision of live heart rate and BORG 0-10

Conclusion

- HIIT type aquatic exercise is an effective and viable training modality for people with mild to severe lower limb OA as well as post arthroplasty.
- There are many different ways to achieve the desired training intensity and effect.
- The training period should start with a gradual period of acclimatizing before reaching highest levels of intensity (BORG 18-20)