Resistance Training for Endurance Athletes: Research and Practical Application

Will Peveler Ph.D.

Question

• Is resistance training beneficial for endurance athletes?
Before 12 weeks of resistance training

After 12 weeks of resistance training

Yes!

• Resistance training in the off-season will lead to increased performance
• Of the 19 studies reviewed, 16 support increased performance
• The other three show no significant differences
Off-Season

- There is no “off” in off-season
  - Last about 3-5 months
  - Decrease volume and intensity
  - Recover physically and mentally
  - Work on power for next season
  - Maintain necessary endurance base

• Resistance training for endurance athletes is not a “strength” training program
• You can not adapt a body building or strength program
• Too high volume
• Common mistake made by lay population

Effects of Resistance Training on Endurance Performance

- Concurrent training interferes with optimal strength gains (Hickson 1980)
- Not a concern for endurance athletes
- Research has demonstrated that concurrent training does not negatively impact endurance performance
• No alteration in VO2max
• No decrease in endurance performance measures
• Resistance training does not increase aerobic capacity
  – VO2max Measures remain unaltered due to resistance training
    • Even when increases in performance are evident

Improved Performance

• Increase in Time to exhaustion
  – Hickson et al. (1988)
    • Short-term endurance (5-8 min) increased by 11% (cycling) and 13% (Running)
    • Long-term (69-85 min) increased by 20% (cycling)
    – Running not measured in long-term (injury)
  – Storen et al. (2008)
    • Increased time to exhaustion by 20.3%, while running at maximal aerobic speed

  – Marcinik et al. (1991)
    • Cycling time at 75% of VO2max increased by 33%
• Increases in performance over a fixed distance or time
  – Aagaard et al. (2007)
    • Short-term endurance (distance traveled in 5 min) increased by 3-4%
    • Long-term endurance (distance traveled in 45 min) increased by 8%
  – Paavolainen et al. (1999)
    • 5 km running time improved by 3.1%

• Spurrs, Murphy, & Watsford (2003)
  – 3 km run time improved by 2.7%

• Improvement in economy
  – Johnsten et al. (1997)
    • Improvement in economy running at 214 and 230 m-min⁻¹ (8 & 8.5 mph)
  – Millet et al. (2002)
    • Improvement in economy (3km run at a fixed resistance)
  – Spurrs, Murphy, & Watsford (2003)
    • Improved running economy (VO₂ measures at 12, 14, & 16 km h⁻¹)
– Storen et al. (2008)
  • 5% improvement in running economy at 70% of VO2max
  • Running economy improved at three different submaximal intensities by 6-10%

• Improvements in time to exhaustion and increases in performance can be attributed to improvement in economy
  – Due to no increase in VO2max
  – However, some studies did report an increase in lactate threshold

– Increased performance due to neuromuscular adaptations
  • Increased type I muscle fiber recruitment, which delays type II muscle fiber recruitment
    – Reducing peak tension at submaximal levels
  • Improved motor unit recruitment patterns and synchronization
  • Improved stretch-shortening cycle during running
    – Increased elastic energy from eccentric contraction
    – Reduce contact with ground
• Increased lactate threshold
  – Current research has produced mixed results
  – Increased LT would lead to increased performance

• Body composition
  – Most research does not support significant changes in body composition in endurance athletes
  – Hickson et al. (1988)
    • Muscle biopsy–fiber diameter unchanged after training

• Increased power production
  – Noakes (1988), Nummela et al. (2006), and Paavolainen et al. (1999) suggest that muscle power affects economy.
  – For sprints and climbing
• Decrease the risk of overuse injuries
  – Decrease muscle imbalance
  – Increased joint stability
  – Improved biomechanics

• Increased bone density
  – Important for cyclists and swimmers
  – Site specific

• Most swimming studies concentrate on 50-200 meters
  – Trappe and Pearson (1994)
    • Compared pull-ups and dips with traditional weight training
    • 365.8 meter time trial increased in both groups
– Sprint swimming research has demonstrated that resistance training improves:
  • Stroke rate
  • Distance traveled per stroke
  • Both would lead to increased performance in distance swimming as well.

Practical Application

• The average off season is about 12 weeks long.
  – When examining the training length of 13 studies:
    • Mean of 9.31 ± 3.28 weeks
    • Range = 5-16 weeks
    • Improvement was evident even in 5 and 6 week programs

Specificity

• Exercises should be sport specific
  – Look at angle and speed of action
  – Cycling:
    • Soleus
  – Swimming:
    • Rotator cuff muscles
  – Working core important for all
Types of Resistance Training

- Weight Training
- Plyometrics
- Body management

Sport specific resistance

- Cycling:
  - Tension intervals
  - Hill repeats
- Running:
  - Hill repeats
  - Stadium workouts
- Swimming:
  - Tethered swimming
  - Paddles
  - Dry-land

Sudden increases in sport specific resistance training can lead to injury
• Research shows improvement with all types of resistance training
  – Plyometrics
  – Weight Training
    • High reps/low weight
    • High reps high speed
    • Low reps/high weight
• To date, one has not been shown to be more effective than another

Sedano et al.
• differences between strength training (3 sets, 7 reps) and plyometrics, muscular endurance (3 sets, 20 reps), and a control group (band).
• Both resistance groups improved significantly in strength, running economy, and peak velocity.
• Only the strength and plyo group increased 3km run time.
Repetition and Sets

• There is not a consensus on the correct amount of reps
  – Low reps (4-6), mid reps (8-12), and high reps (up to 30) appear to work.
• Sets 1-3

• Number of exercises
  – Keep program low volume
  – One large movement/muscle group
  – One small movement/muscle

Developing a program

• Start slowly
  – DOMS
    • Cycling: no eccentric motion
  – Injury
• Technique
  – Endurance athletes may not be familiar with proper technique
• Days per week
  – One to three
  – Start with two days in the weight room and one sport specific resistance
  – When you move from off-season to preparation phase drop to one day/week.
  – Stop resistance training during competition phase
    • Can keep one day/week sport specific resistance

• Volume
  – Do not add weight training on top of normal off-season volume
  – Jackson, Hickey, & Reiser (2007)
    • Three groups:
      – Cycling only
      – High resistance (4 reps)
      – High repetition (20 reps)
    • No differences in performance between any group

• Both resistance protocols were added on top of cycling
• Subjects were also conducting hill repeats and intervals
• Too high volume
• Subjects stated that they would not be able to keep up the volume of training
• Must keep an aerobic base

Contact Information

• Will Peveler Ph.D.
• Email: pevelerw1@nku.edu
• Office: (859) 572-5960

