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Strength Training for Endurance Athletes

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Sion, 27.08.2015

Strength training for endurance athletes

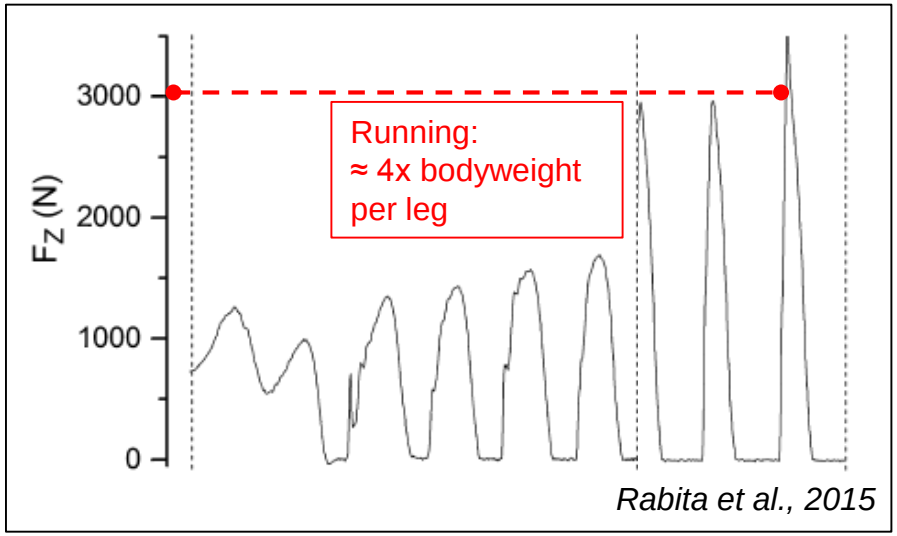
- **Can strength training make me faster?**

- **Can strength training make me healthier?**

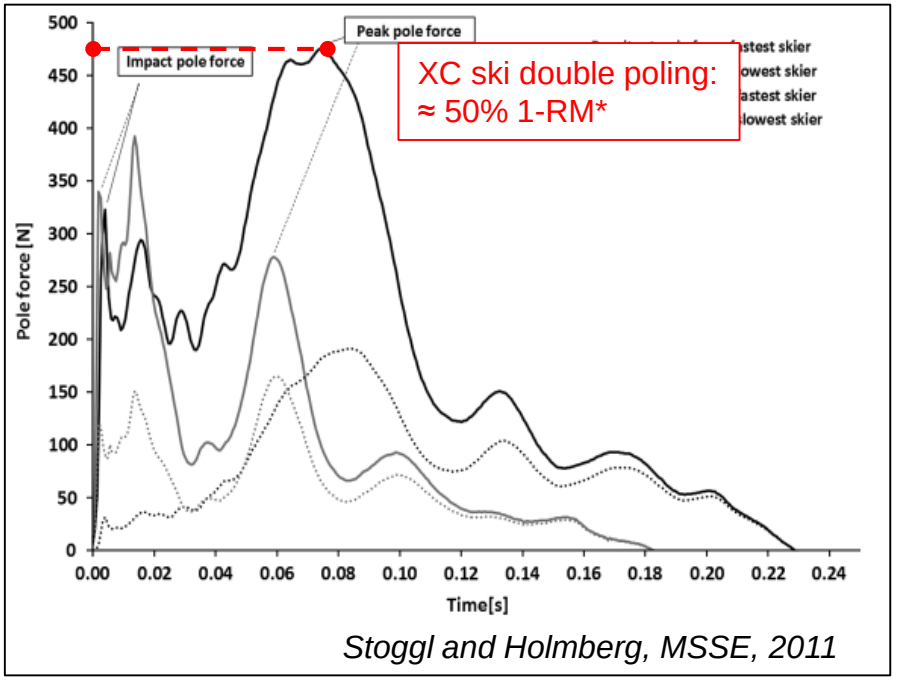
Strength training for endurance athletes

- **Not all strength training forms are equal**
  - Hypertrophy, maximal strength, explosive strength/power, reactive strength
- **Not all endurance events are equal**
  - Running, cycling, XC skiing, triathlon
- **Athletes (within a sport) are not all the same**
  - *e.g.* sprinters, time-trialists and climbers in cycling
  - Differences in training volume

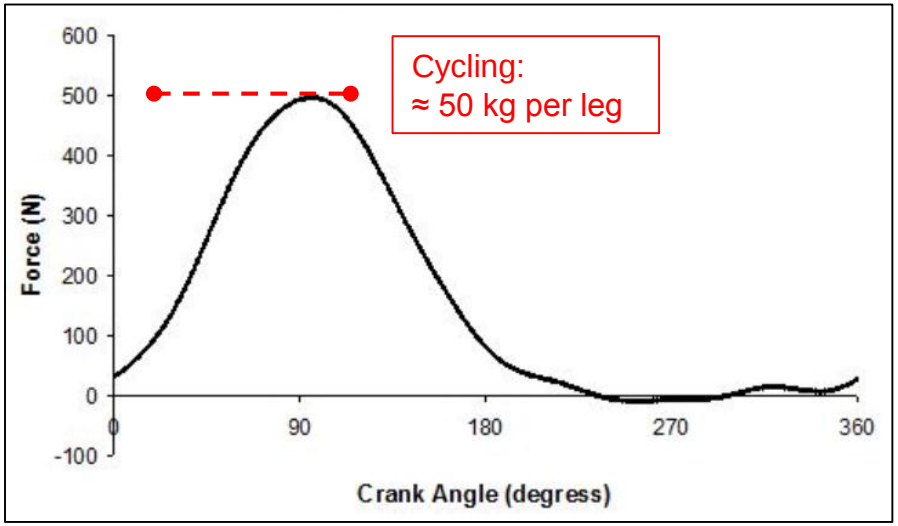
Forces in endurance events



Rabita et al., 2015

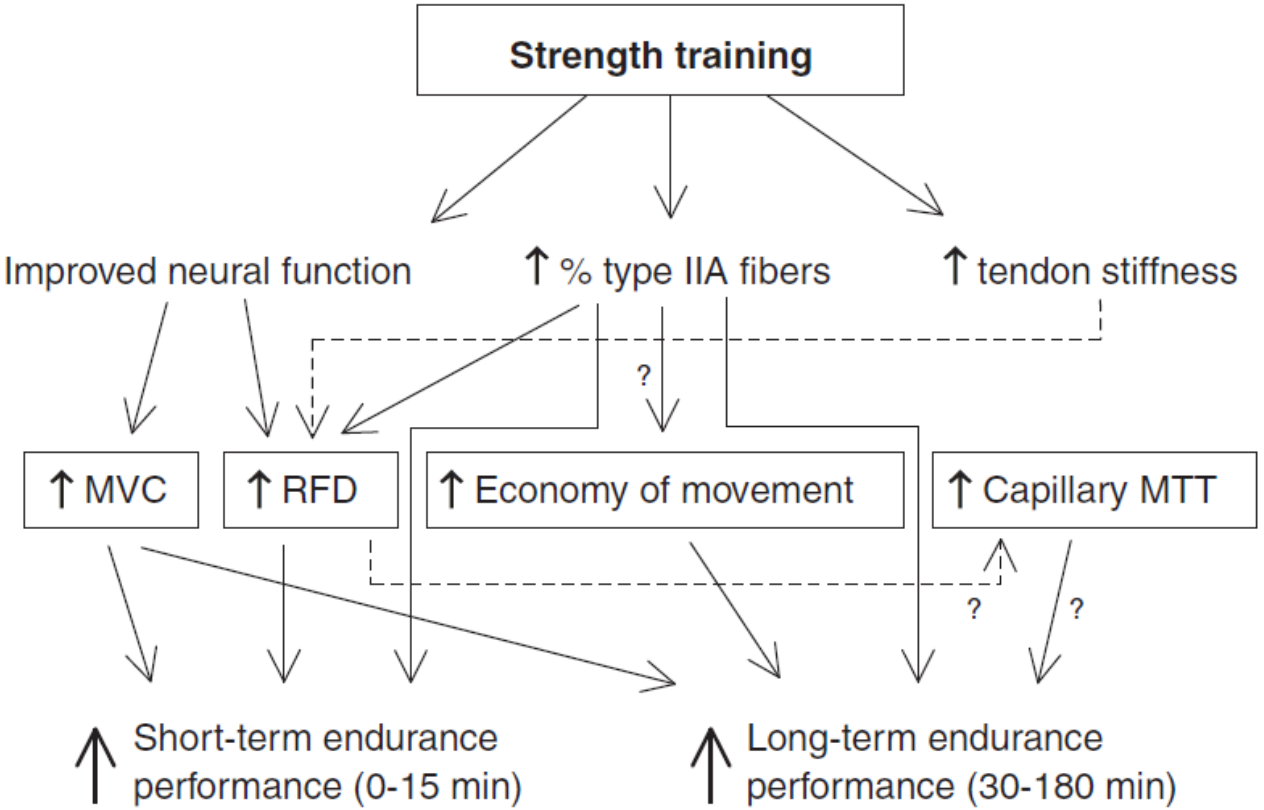


Stoggl and Holmberg, MSSE, 2011



Strength training for endurance athletes

Proposed benefits



Aagaard & Andersen 2010, Effects of strength training on endurance capacity in top-level endurance athletes.

Strength training for endurance athletes

Proposed *direct* benefits

- Sprinting ability
- Economy of movement
- Maximal sustainable work rate
- Body composition

Indirect benefits

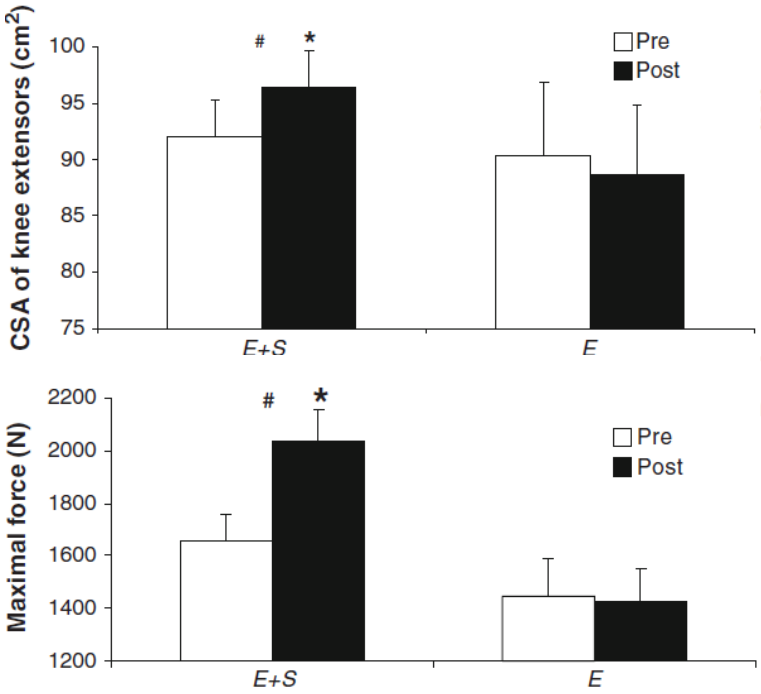
↑ Technical stability

↓ monotony in training

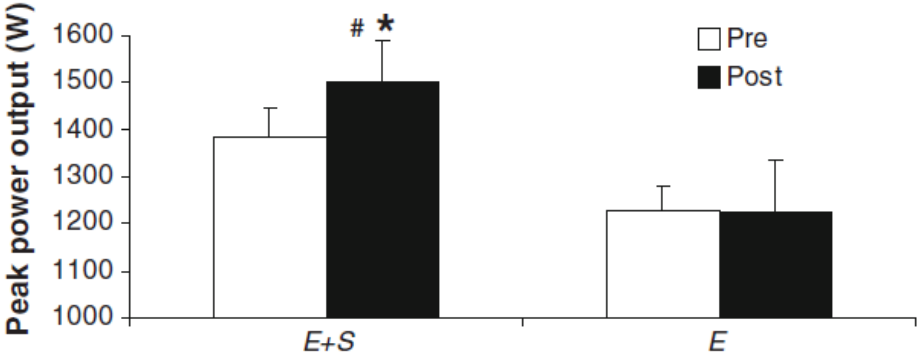
↓ susceptibility to injury

Benefits of strength training for endurance performance

Muscle mass, anaerobic capacity, sprint performance



Wingate



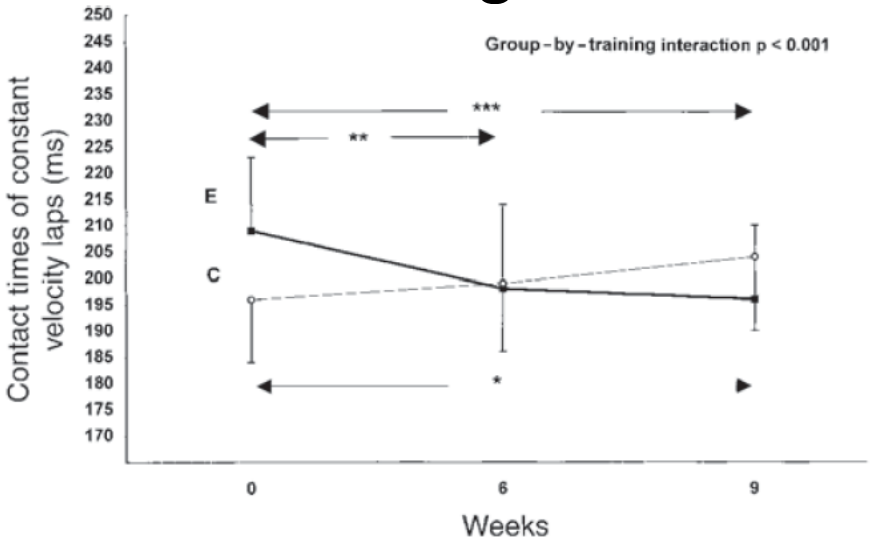
10-RM, 2/wk, 12 wk

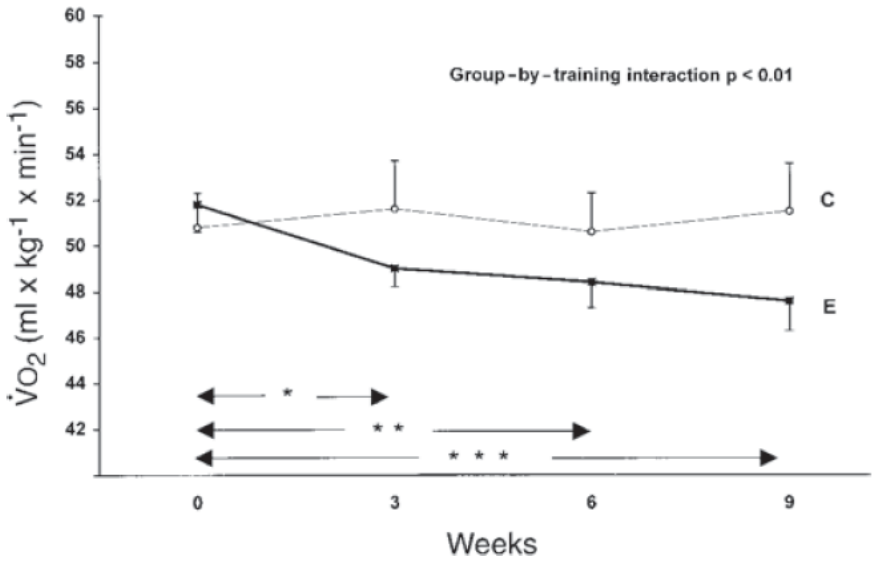
Ronnestad et al. 2010, *Effect of heavy strength training on thigh muscle cross-sectional area, performance determinants, and performance in well-trained cyclists.*

Benefits of strength training for endurance performance

Economy of movement

- **Running**





- Sprints, jumps, and weights, maximal movement velocity, 9 wk

Paavolainen et al. 1999, *Explosive-strength training improves 5-km running time by improving running economy and muscle power.*

Benefits of strength training for endurance performance

Economy of movement

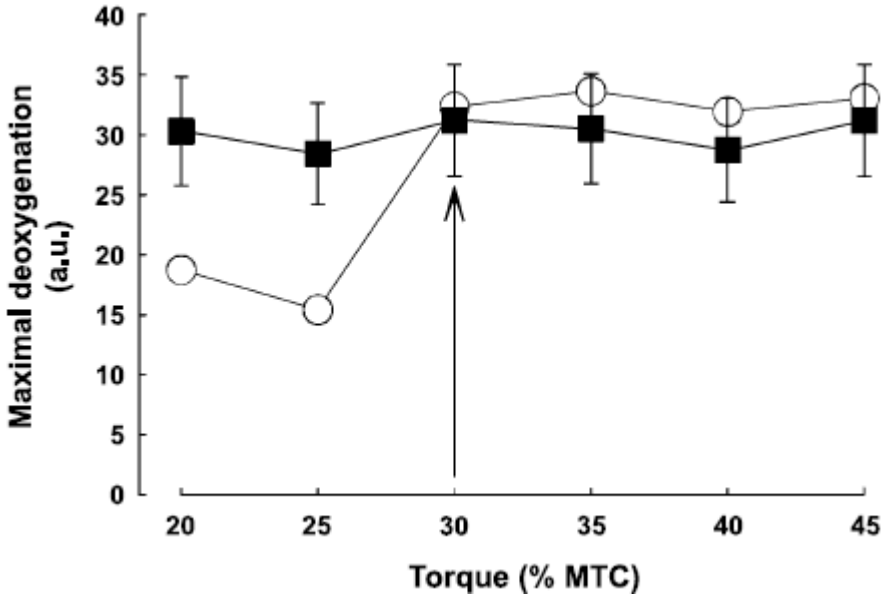
- **Cycling** *(Sunde 2010, Louis 2012, Vikmoen 2015)*
- **XC Skiing** *(Hoff 1999, Hoff 2002, Osteras 2002)*

- Heavy weight training (4-10 RM loads), 2-3/wk, 8-12 wk

Benefits of strength training for endurance performance

Maximal sustainable work rate

- ↑ F_{max}



de Ruiter et al. 2007, *The isometric torque at which knee-extensor muscle reoxygenation stops*.

Benefits of strength training for endurance performance

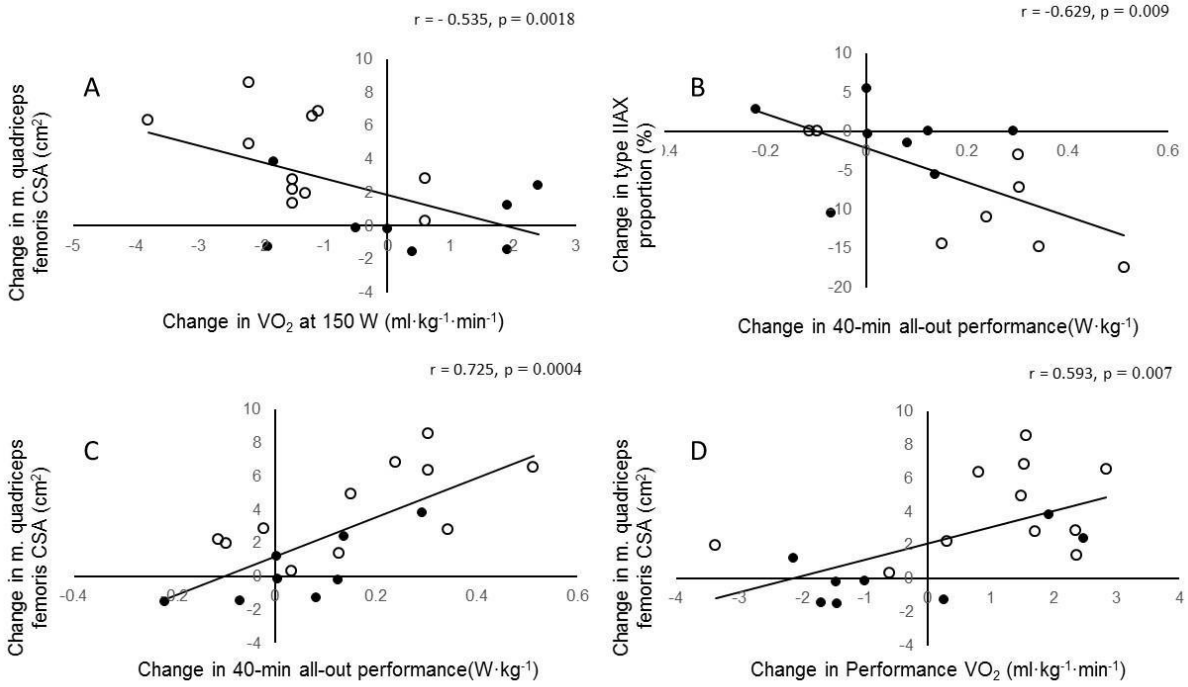
Maximal sustainable work rate

Related to

- ↑ **CSA** *(Vikmoen 2015)*
- **Fiber-type shift IIX→IIA** *(Aagard 2011, Vikmoen 2015)*
- ↑ **RFD** *(Aagaard 2015, Sunde 2009, Hoff 1999, Hoff 2002, Ronnestad 2015)*
- ↑ **sustainable %$\dot{V}O_2$max** *(Vikmoen 2015)*

Benefits of strength training for endurance performance

Maximal sustainable work rate



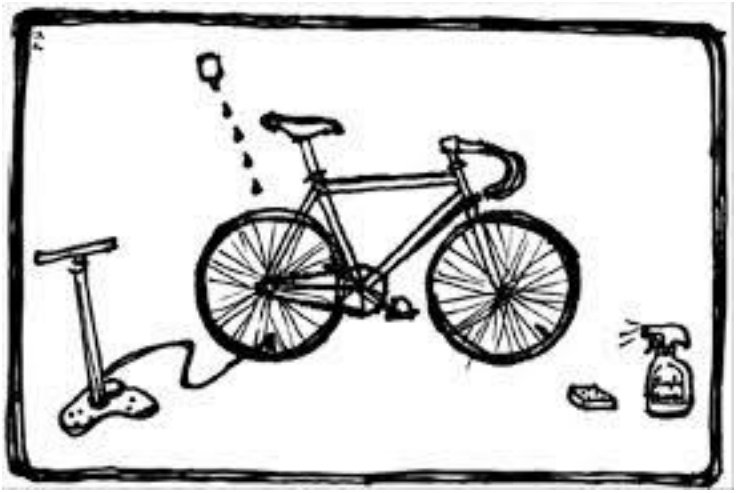
Vikmoen, O., et al., *Strength training improves cycling performance, fractional utilization of VO and cycling economy in female cyclists.* Scand J Med Sci Sports, 2015.

Benefits of strength training for endurance performance

Body composition

- Reduced body fat content
- Prevent muscle loss

Benefits of strength training for endurance performance



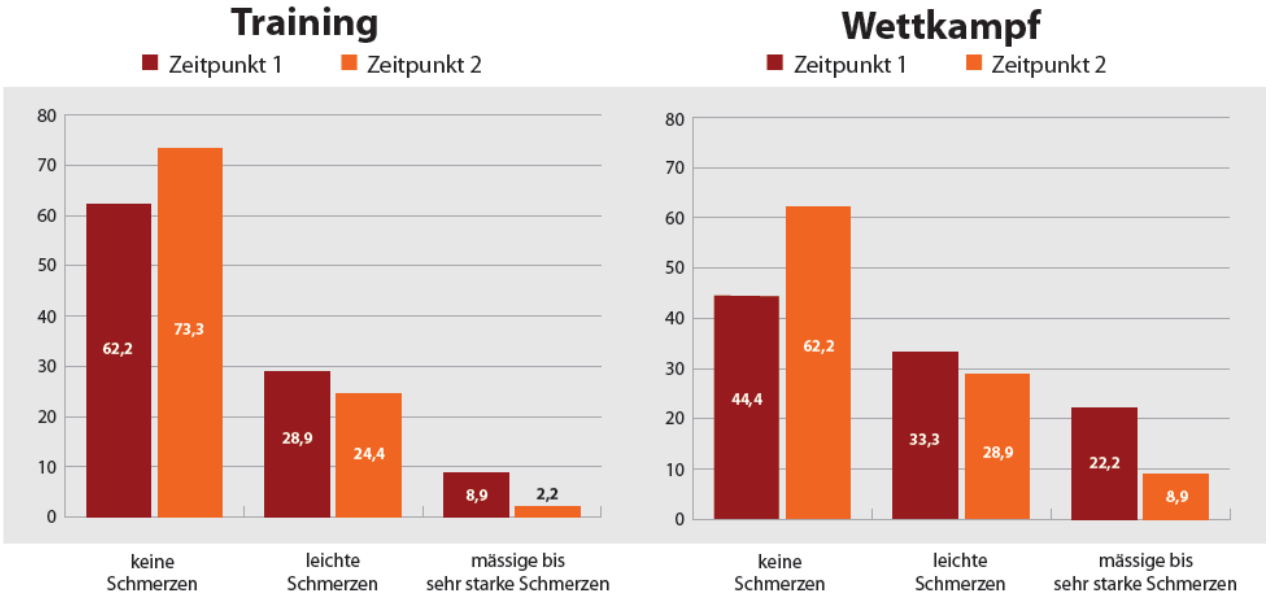
Reduced susceptibility to injury

- Prevent muscle imbalance
- ↑ integrity of bone and connective tissue
- ↑ stability of joints
- Balance and flexibility
- ↑ core stability

Benefits of strength training for endurance performance

Reduced susceptibility to injury

- ↑ core stability



Ruckstuhl, L., et al., *Rückenbeschwerden und Rumpfkraft im Schweizer Spitzenradsport*, in *Schweizerischer Sportmedizin-Kongress*. 2008.

Strength training: yes or no

- **Importance of sprinting or accelerating**
- **Presence of especially high forces or eccentric contractions**
- **General weakness (limiting factor)**
- **Large training volume (resilience to injury, monotony)**

Application: practical issues

Interference

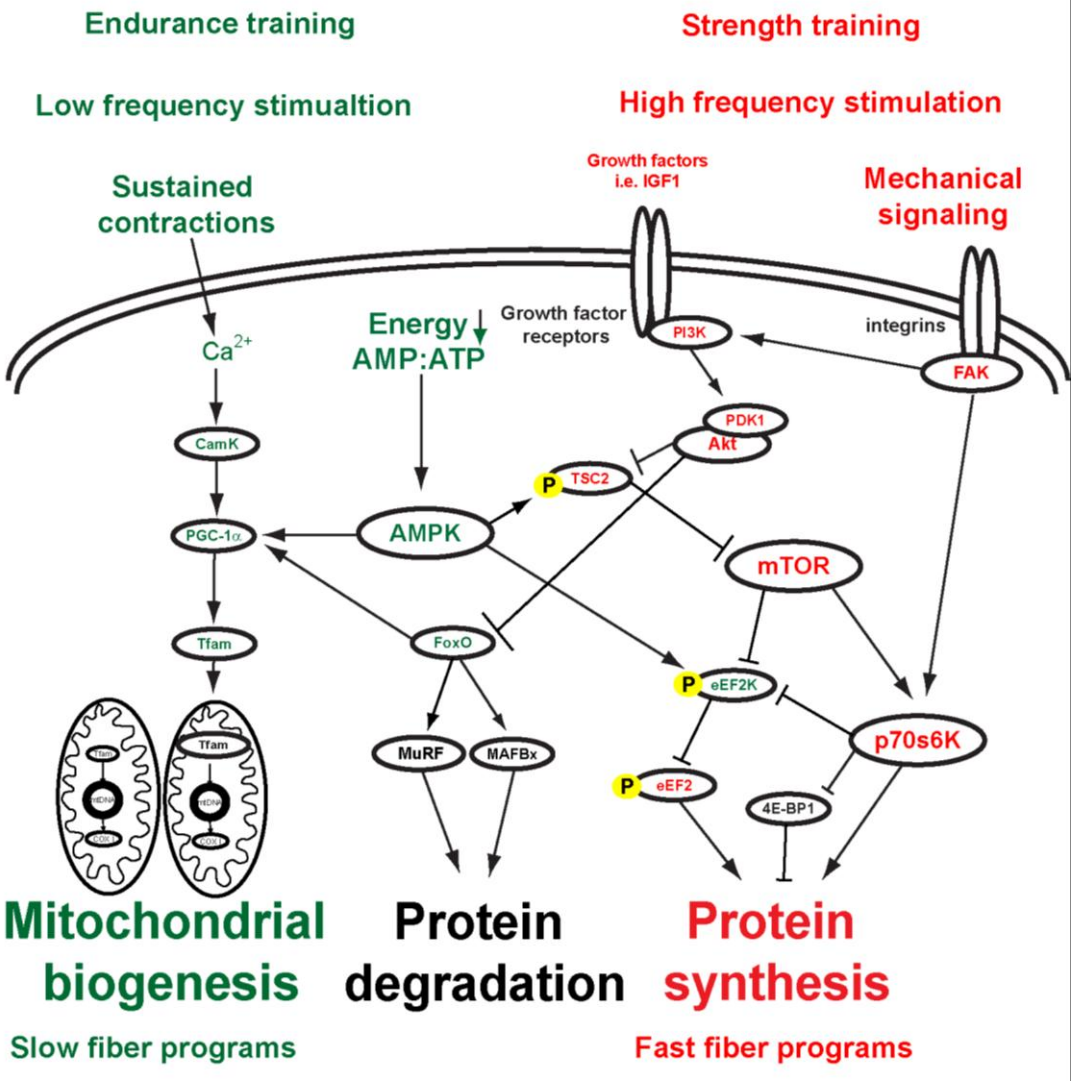
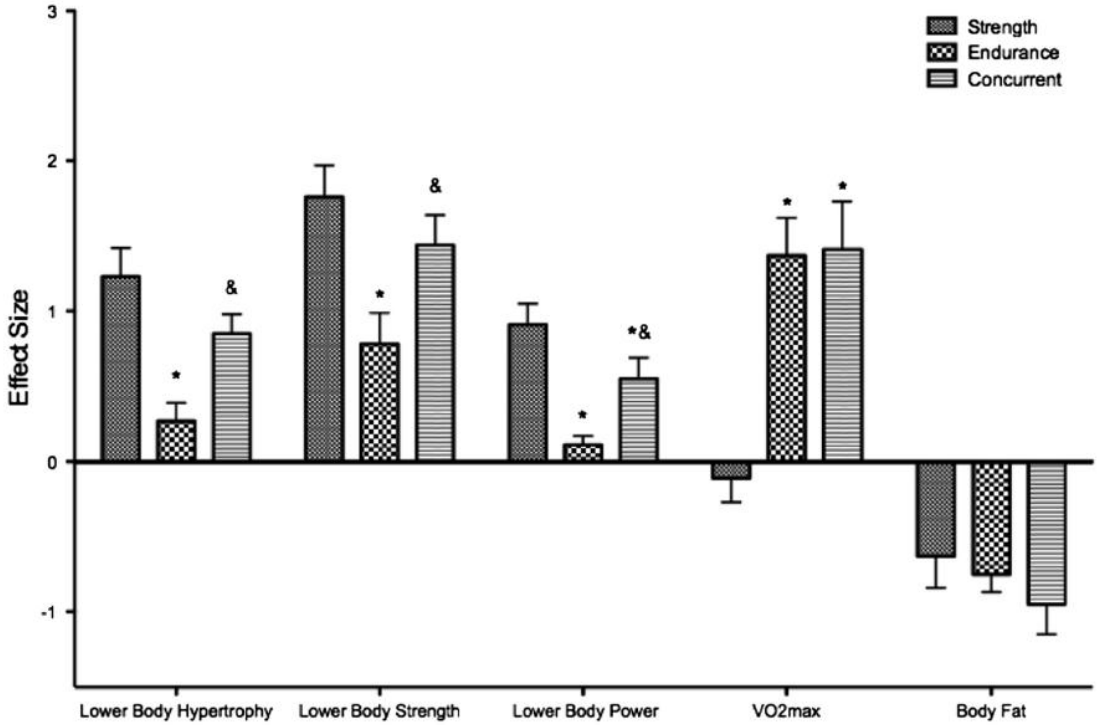


Diagram: H. Hoppeler

Application: practical issues

Interference: endurance adaptations relatively unaffected



Wilson et al. 2012, *Concurrent training: a meta-analysis examining interference of aerobic and resistance exercises.*

Application: practical issues

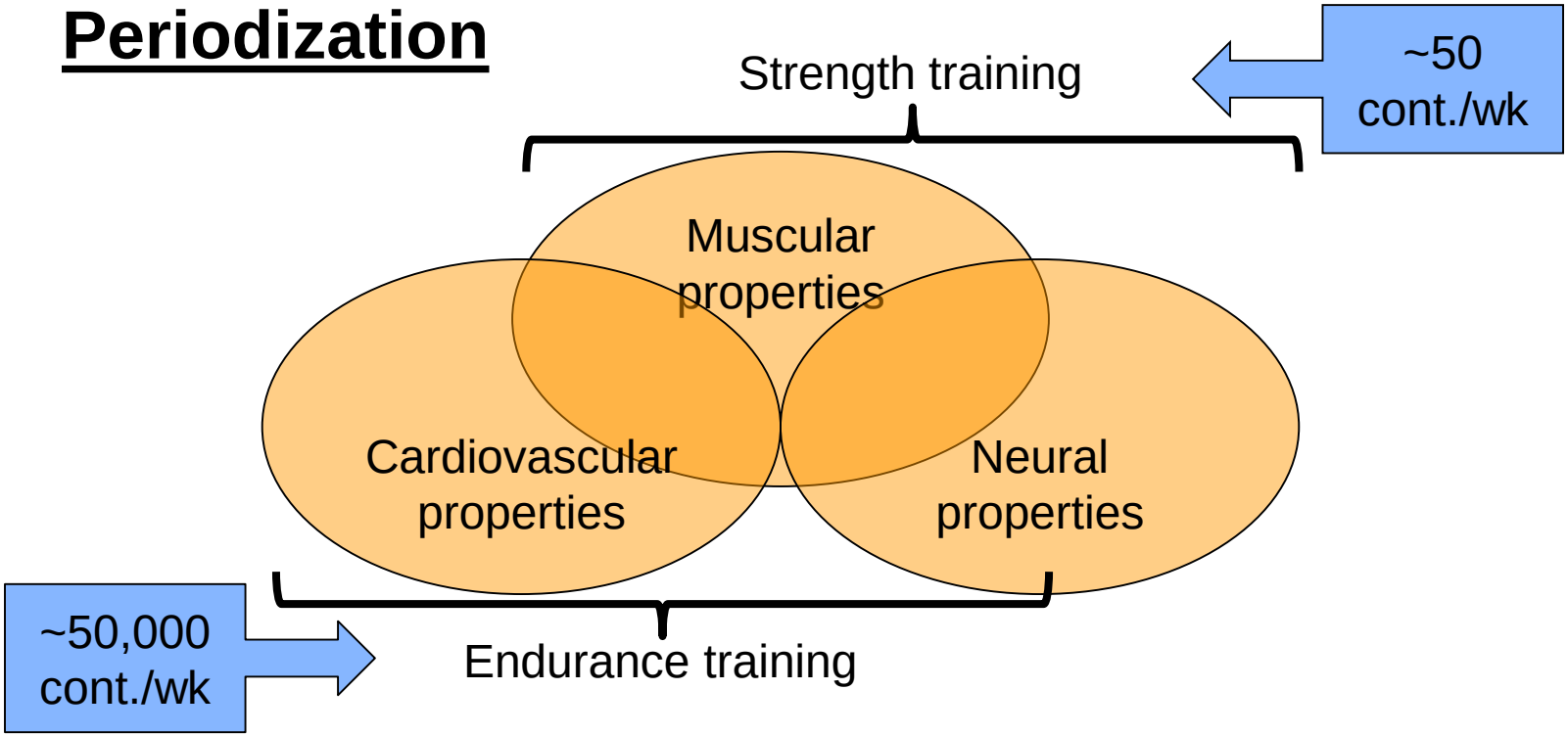
Periodization

Rest day

- **Before or after strength session?**
- **Hypertrophy vs. neural**

Application: practical issues

Periodization

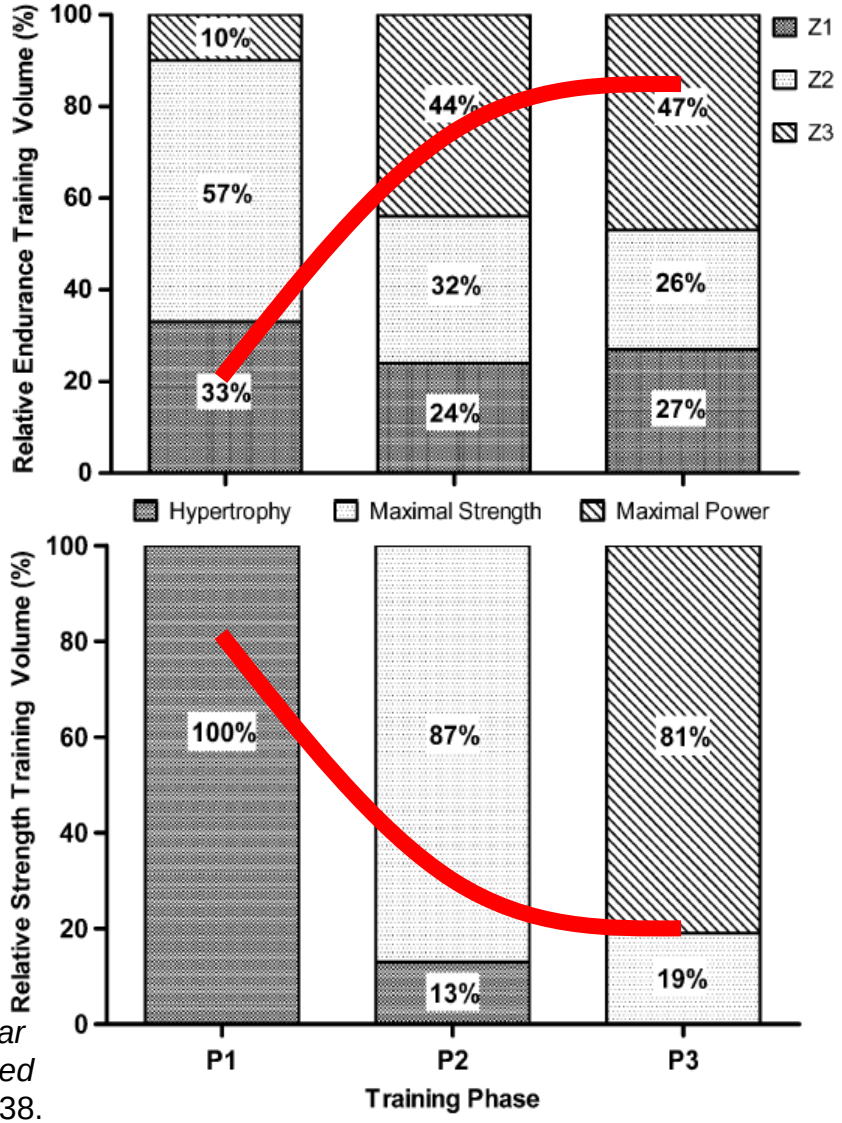


Adapted from Docherty & Sporer, *A proposed model for examining the interference phenomenon between concurrent aerobic and strength training.* Sports Med, 2000. **30**(6): p. 385-94.

Application: practical issues

Periodization

Acute fatigue



Garcia-Pallares, J., et al., *Endurance and neuromuscular changes in world-class level kayakers during a periodized training cycle.* Eur J Appl Physiol, 2009. **106**(4): p. 629-38.

Application: practical issues

Strength training form

- **Maximal strength (4-6 RM)**
  - 1-RM, RFD, *F-v* profile
  - Cycling efficiency, W_{max}, $TT_{5\text{-}45\ min}$, $Sprint_{Wingate}$
  - XC skiing economy, DP vVO_2max

- **Reactive strength (sprinting, jumping, hopping, bounding)**
  - MVC_{iso}, RFD, CMJ
  - Running economy, vVO_2max, $TT_{3\text{-}5km}$

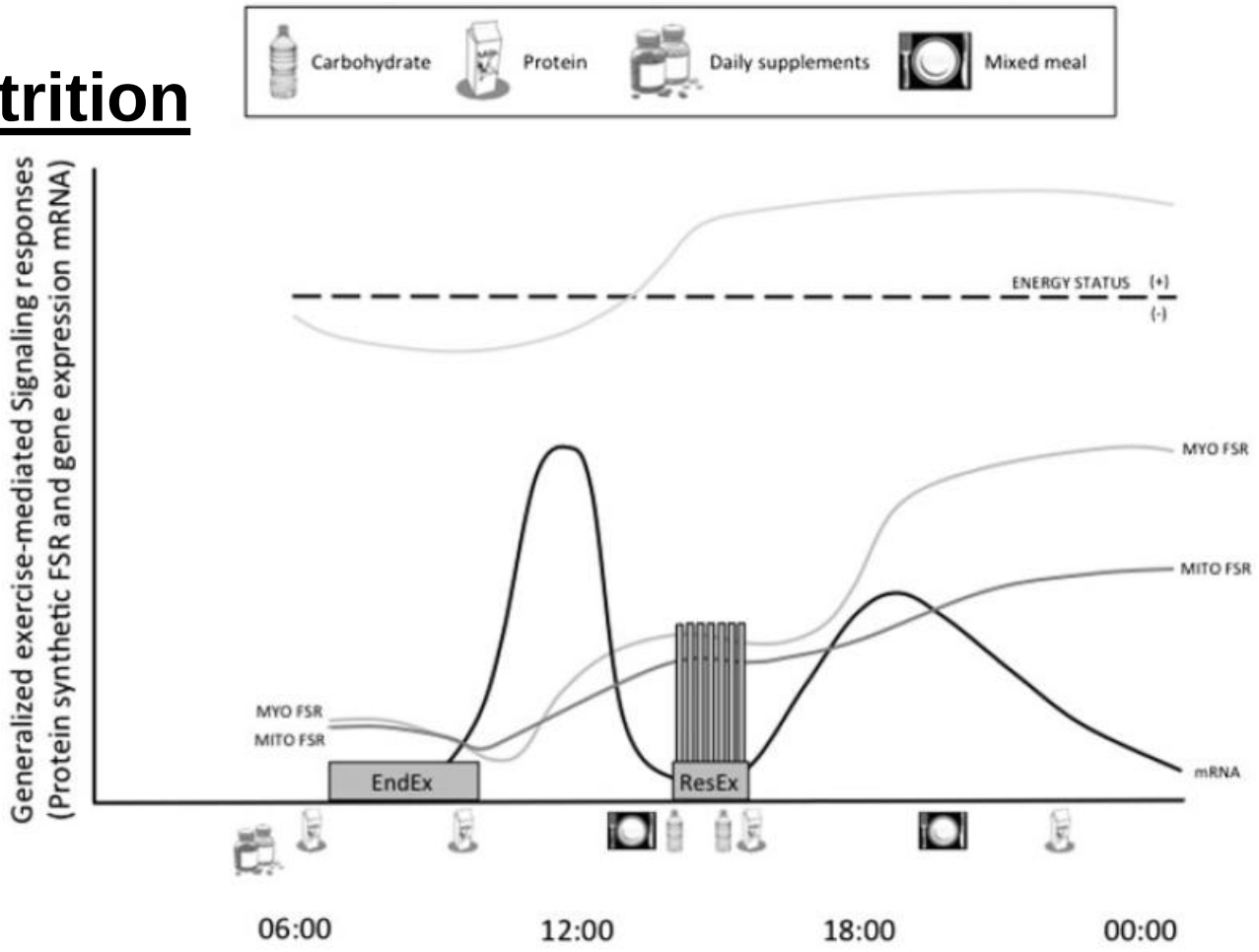
Application: practical issues

Nutrition

- **Protein**
- **Carbohydrate**
- **Caloric balance is main determinant of body weight**

Application: practical issues

Nutrition



Perez-Schindler, J., et al., *Nutritional strategies to support concurrent training.* Eur J Sport Sci, 2015. **15**(1): p. 41-52.

Take home message

- **For performance**
  - Supplementary, not substitutional
  - Deficit oriented
  - “can’t hurt, but could help”
- **For health**
  - Recommended for prevention and rehabilitation

Take home message

<u>Strength training recommended if</u>:

- **Sprint finish or mid-race "*attacks*" are crucial**
- **Event requires high force or eccentric impact**
- **Ratio W_{max}:$W_{\dot{V}O_2max}$ is low**
- **Training volume is large**

Take home message

- **Runners: Reactive strength**
  - Sprints, jumps, plyometrics
- **Cyclists, XC skiers (and weak runners): Maximal strength**
  - Squats, dead lifts, 1-leg press
  - (Sprints)
- **Triathletes: either or both**

References

1. Aagaard, P. and J.L. Andersen, *Effects of strength training on endurance capacity in top-level endurance athletes.* Scand J Med Sci Sports, 2010. **20 Suppl 2**: p. 39-47.
2. Aagaard, P., et al., *Effects of resistance training on endurance capacity and muscle fiber composition in young top-level cyclists.* Scand J Med Sci Sports, 2011. **21**(6): p. e298-307.
3. de Ruiter, C.J., et al., *The isometric torque at which knee-extensor muscle reoxygenation stops.* Med Sci Sports Exerc, 2007. **39**(3): p. 443-53.
4. Docherty, D. and B. Sporer, *A proposed model for examining the interference phenomenon between concurrent aerobic and strength training.* Sports Med, 2000. **30**(6): p. 385-94.
5. Garcia-Pallares, J., et al., *Endurance and neuromuscular changes in world-class level kayakers during a periodized training cycle.* Eur J Appl Physiol, 2009. **106**(4): p. 629-38.
6. Louis, J., et al., *Strength training improves cycling efficiency in master endurance athletes.* Eur J Appl Physiol, 2012. **112**(2): p. 631-40.
7. Mikkola, J.S., et al., *Concurrent endurance and explosive type strength training increases activation and fast force production of leg extensor muscles in endurance athletes.* J Strength Cond Res, 2007. **21**(2): p. 613-20.
8. Paavolainen, L., et al., *Explosive-strength training improves 5-km running time by improving running economy and muscle power.* J Appl Physiol (1985), 1999. **86**(5): p. 1527-33.
9. Perez-Schindler, J., et al., *Nutritional strategies to support concurrent training.* Eur J Sport Sci, 2015. **15**(1): p. 41-52.
10. Ronnestad, B.R., E.A. Hansen, and T. Raastad, *Effect of heavy strength training on thigh muscle cross-sectional area, performance determinants, and performance in well-trained cyclists.* Eur J Appl Physiol, 2010. **108**(5): p. 965-75.
11. Sunde, A., et al., *Maximal strength training improves cycling economy in competitive cyclists.* J Strength Cond Res, 2010. **24**(8): p. 2157-65.
12. Vikmoen, O., et al., *Strength training improves cycling performance, fractional utilization of VO and cycling economy in female cyclists.* Scand J Med Sci Sports, 2015.
13. Wilson, J.M., et al., *Concurrent training: a meta-analysis examining interference of aerobic and resistance exercises.* J Strength Cond Res, 2012. **26**(8): p. 2293-307.

The Ironmam says: