

Exercise and respiratory muscle fatigue

Can breathing be
trained?

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9th November 2011

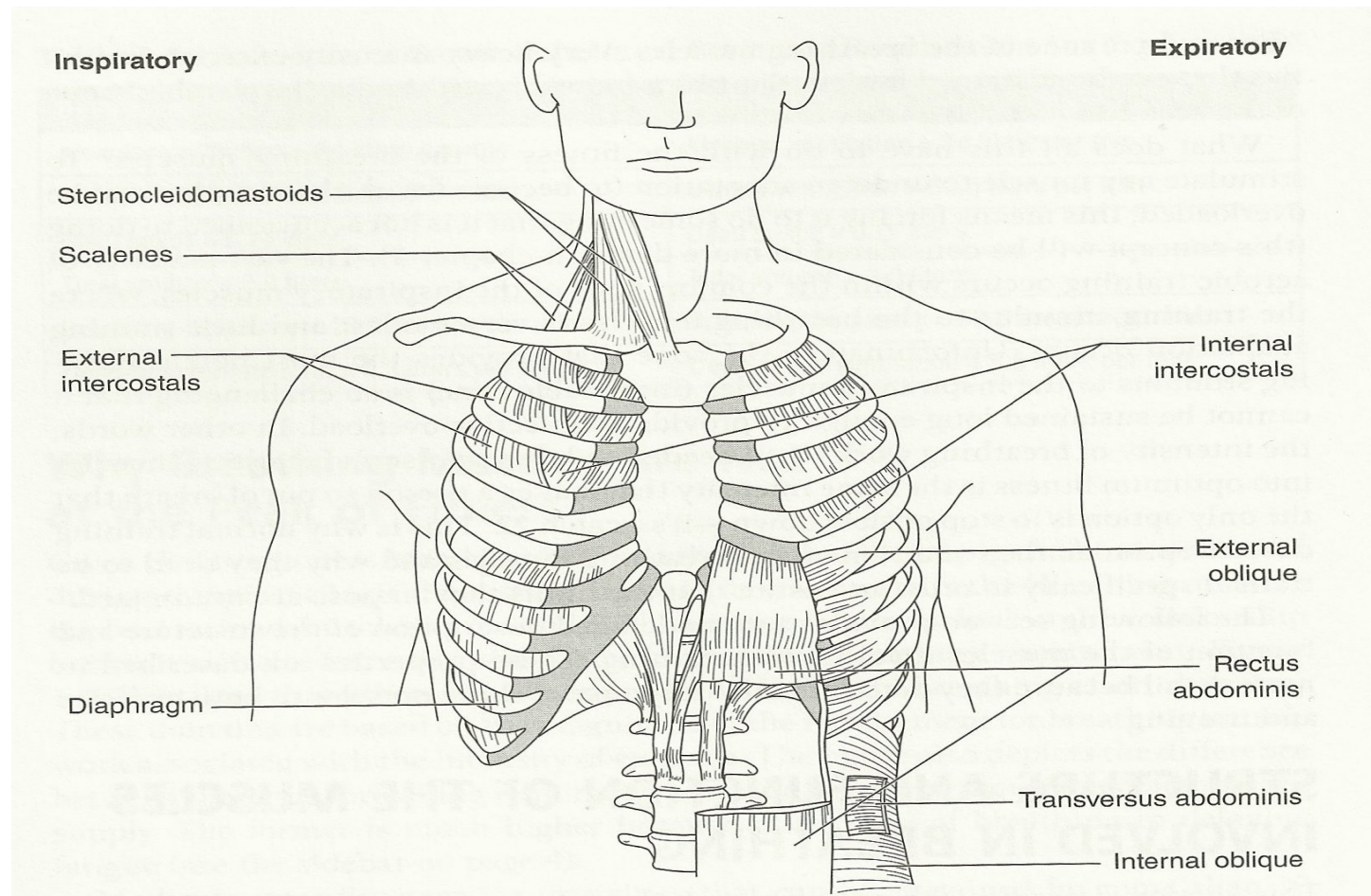


Outline

- Respiratory muscles
- Respiration and exercise
- Respiratory muscle fatigue
 - Respiratory muscle fatigue and exercise
- Respiratory muscle training



Respiration



Modified from McConnell (2011) p16

Respiration and exercise

	Rest	Heavy exercise
Breaths/min	10-15	40-50
Tidal volume (L)	0.5	3-4
Minute ventilation (L/min)	7.5	120-160

- Dyspnea occurs
- Majority of work = inspiratory muscles (16% available O₂, Aaron et al, 1992)
- As intensity ↑ tidal volume levels off, breathing frequency ↑

What is respiratory fatigue?

- Defined as: ‘an inability of the respiratory muscles to continue to develop sufficient respiratory pressure to maintain normal alveolar ventilation’ (Grassimo et al, 1984).
- Does not tend to occur during rest in healthy people
- Common during intense exercise





Limitations of respiratory muscles

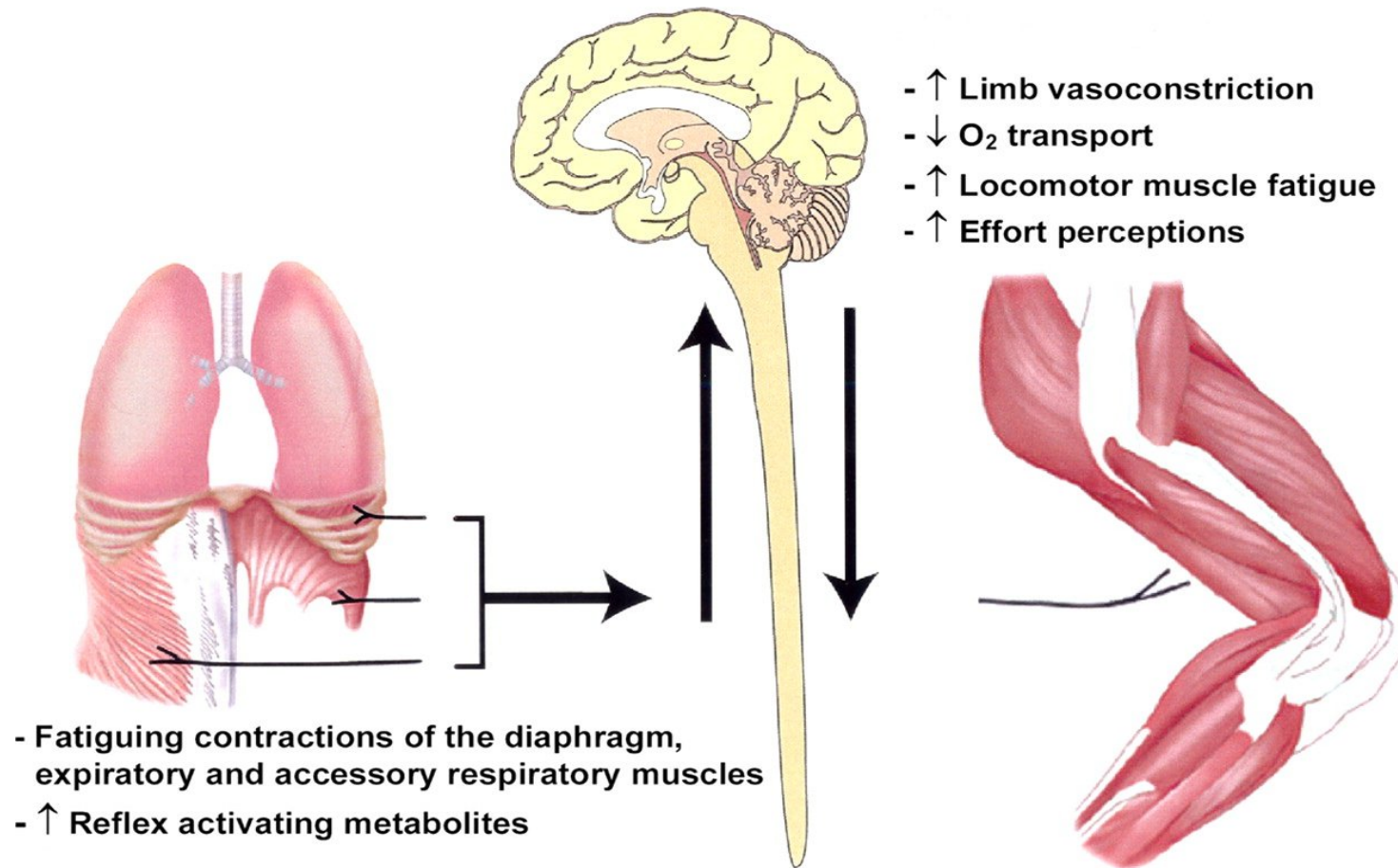
- Diaphragm fatigue
- Whole body endurance exercise induces fatigue of the diaphragm (Babcock et al, 2002)
- During exercise the diaphragm must compete with locomotor muscles for its share of available cardiac output (Harms et al, 1998)
- Less blood flow to the diaphragm = inadequate O₂ transport to diaphragm, ↑ likelihood of fatigue
 - 80–85% of VO₂max



Respiratory muscle fatigue and exercise tolerance

- Pre fatiguing respiratory muscles = decreased ability to sustain exercise
 - E.g. decrease in time cyclists (Mador and Acevedo, 1991) or runners (Verges et al, 2007) could sustain high intensity exercise
- ‘Inspiratory muscle metaboreflex’ Sheel et al (2002)

RESPIRATORY MUSCLE METABOREFLEX



Romer L M , Polkey M I J Appl Physiol 2008;104:879-888

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Can breathing be trained?



Respiratory muscle training

- IMT found to be most beneficial
- Inspiratory pressure threshold loading
- To improve strength – overload muscles
- 60% load advised (30 RM)
- POWERbreathe – medical and exercise setting



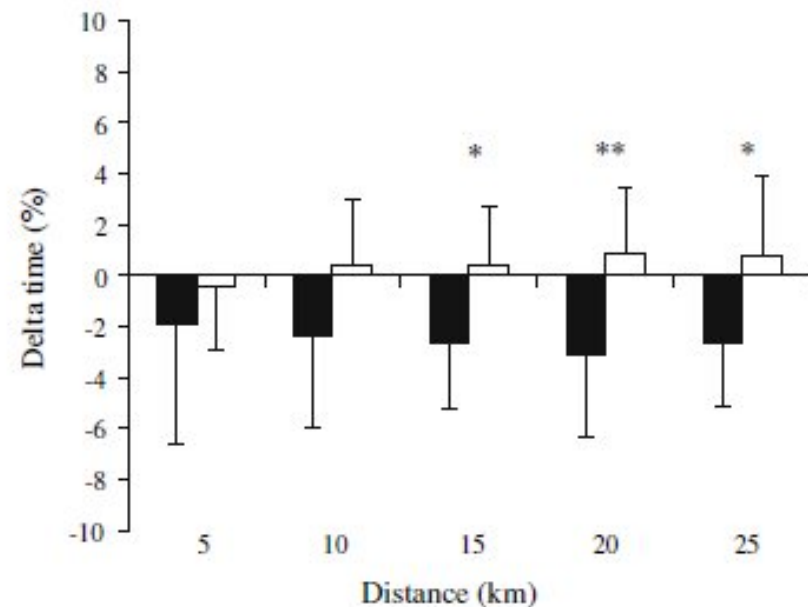


Inspiratory muscle training: the evidence

- Strength gains
- Downey et al. (2007)
 - Thickness of diaphragm ↑ 12% after 4-8 weeks IMT
 - Inspiratory muscle strength ↑ 24% after 4 weeks and 41% after 8 weeks

Inspiratory muscle training: the evidence

- Johnson *et al.* (2007)
- Effect of IMT on cycling time trial performance
- POWERbreathe, 30 breaths/day, 50% MIP for 6 weeks
- 2.7% improvement in 25k TT performance
- Similar to other studies (20k TT, 3,8%, Romer *et al.*, 2002)





Conclusions

- Exercise = ↑ demand on respiratory muscles
- Exercise of sufficient intensity/duration can cause respiratory muscle fatigue
- This can trigger the ‘inspiratory muscle metaboreflex’ and limb fatigue
- Inspiratory muscle training of 4 weeks or more can improve muscle strength and sports performance



Directed reading

- McConnell (2011) Breathe Strong Perform Better Human Kinetics: Champaign, ILL
- Romer and Polkey (2007) Exercise induced respiratory muscle fatigue J Appl Physiol 104, 879-888
- Johnson et al (2007) Inspiratory muscle training improves cycling time-trial performance and anaerobic work capacity but not critical power Eur J Appl Physiol, 101, 761-770