Are you making good use of your breathing muscles?

By Eddie Fletcher

Introduction

If you could improve your performance by 1% 2% or even 3% or more, reduce your breathing effort and recovery during racing and training and all for just 10 to 15 minutes extra training twice a day wouldn't it be worth-while?

Athletes spend huge amounts of time on technique and training their cardiovascular system and specific muscle groups but neglect to train their breathing muscles (known as inspiratory and expiratory muscles – inhaling and exhaling).

The importance of the breathing muscles

The first thing to understand is how important the breathing muscles are. Exercise puts high demands on the breathing muscles, and they are quick to fatigue. The evidence suggests that the respiratory demand of exercise 'steals' blood from the legs[1] during exercise causing fatigue in the breathing muscles and reduces performance. There is more likelihood of fatigue as the intensity of exercise increases[2] so attention paid to training the breathing muscles will be time well spent.

Research suggests that by strengthening the breathing muscles blood flow demand from the respiratory muscles is reduced, cardiac output to the leg muscles is increased and performance improves[1]. And there may be other benefits following breathing muscle training such as reduced lactate, reduced heart rate, reduced maximal force required for each breath, decreased respiratory effort, increased tidal volume and deeper breathing so in addition to improved performance recovery following exercise may also be improved.

What is the evidence?

There is evidence to suggest that fatigue of the breathing muscles limits performance in several sports. In a 1991[3] experiment the inspiratory muscle strength of competitors was measured during a triathlon of 3.8 km swim, 180 km cycle and 42 km run. No significant decline occurred during the swim, but significant breathing muscle fatigue occurred after the cycle (25%) and run (26%). On the shorter Sprint and Olympic distance triathlons the breathing muscles may begin to fatigue during the swim phase due to the intensity of effort.

In a 2001 study of 14 young female rowers inspiratory muscle strength improved by 45% and the distance covered in a six minute all-out rowing effort improved by 1.9% following inspiratory muscle training. In this same 2001 study the gain over 5000 m rowing was even more impressive, a mean gain of 25 seconds. Most of the gains occurred after only four weeks of inspiratory muscle training.

Further research in 2002[5] suggests significant improvement in 40km time trail cyclists

following a period of inspiratory muscle training. In this experiment 20km and 40 km time trail performance improve by a mean of 3.8% and 4.6% respectively reducing 40km time trail performance by up to 3 minutes.

Research in 2003[6] suggests that a single 200m freestyle swim at 90-95% of race pace is sufficient to induce breathing muscle fatigue. Measurements in the swimming position rather than the upright position also indicate that although the diaphragm length is optimised when the body is horizontal the force output of the diaphragm and breathing accessory muscles is greater when upright so breathing muscle fatigue may be a particular problem for swimmers.

At this point with have been talking about the muscles used for inspiration but what of expiration? Research to date suggests that the expiratory muscles may not contribute significantly to breathing whilst the individual is at rest. However, the expiratory muscles do become actively involved at high exercise intensities and research in 2002[7] suggests that the expiratory muscles do fatigue and may also contribute to the constriction of blood in the legs during exercise.

At 85% of maximum oxygen uptake the breathing muscles require up to 15% of total energy spent so for maximal intensity exercise the demand is much greater. Overall, it is clear that the respiratory system limits endurance performance and therefore if correctly trained improved performance should be the result.

The breathing muscles

So getting technical - the main muscles that compose the inspiratory (breathing) muscles and elevate and expand the thorax (chest) are the diaphragm, external intercostals, sternocleidomastoids, scapular elevators, anterior serrate scleni and spinal erector muscles.

During inspiration elongation and expansion of the chest cavity expands the air in the lungs causing the intrapulmonic pressure to decrease slightly below atmospheric pressure. The degree to which the lungs are filled with air depends on the magnitude of inspiratory movement. Inspiration ends when thoracic (chest) expansion stops causing intrapulmonic pressure to increase to equal ambient atmospheric pressure[8].

The result of that technical explanation is that the strength of the breathing muscles will limit the chest expansion and breathing performance. So it probably stands to reason that if you strengthen the breathing muscles under load and then remove the load for training and competition the muscles will be more efficient releasing more oxygen rich blood to other skeletal muscle lowering fatigue all round.

This is the same principle that applies to other forms of more familiar cardiovascular and muscle training.

What are the implications for older athletes?

Many sports appeal to all age groups and the question is whether older athletes can

achieve the results claimed for inspiratory and expiratory muscle training? As the body ages there are physiological changes that limit performance. The ability to take up oxygen reduces by about 10% per decade in men and women regardless of age or exercise activity[9].

High intensity exercise may reduce this loss in young and middle-aged men by 50% but not in older men and for middle aged and older women it does not appear that loss rates can be reduced[9]. Muscle mass reduces, particularly fast twitch muscle and there is a consequent loss of ability to produce powerful muscle contractions. This loss of muscle mass is most severe during the 4th decade where research has shown a decline in power of 3% per annum (in powerlifting) with 1% per annum every year thereafter10. Crucially for age group athletes the effectiveness of training for muscle strength decreases rapidly with age.

Cardiovascular and respiratory function also reduces for instance rowing research suggests that endurance capacity in men reduces by 0.12% per annum between ages 25-55 and in women 0.23% per annum[10]. The implication is that age groupers can continue to perform effectively for endurance events but may struggle in power activities that require maximal effort.

In a recent randomly controlled experiment, the author subjected 16 age group indoor rowers aged 36 – 63 to a 1609 m maximal row before inspiratory muscle training and again after 30 days of inspiratory muscle training. In the 30-day training period inspiratory muscle strength improved by a 31.8% in the training group over the placebo group. Seven of the eight in the training group achieved personal bests in the second 1609 m trial whilst only two in the placebo group lowered their personal bests.

Overall, the average time of the training group improved by 1.8 seconds whilst the average time of the placebo group declined by 1.8 seconds. Statistically, the difference between the groups was significant for both inspiratory muscle strength and 1609 m rowing performance. The statistical analysis also suggested that a large proportion of the improvement was due to the inspiratory muscle training.

So, what does this mean?

My conclusion is that inspiratory and expiratory muscle strength training and competitive performance are improved by use of a breathing training device to improve breathing muscle strength in both male and female across the age range and in the majority of sports. However whilst I believe that the breathing muscle strength gains can be held, further research is needed to establish whether the performance time gain can be retained, what impact individual physical and physiological factors have and whether there are any gender differences.

I think that the performance time gains may reduce with advancing age and that the main benefit for older athletes may be in coping better with the physiological demands of basic exercise, training and competitive performance. The rowers in my experiment are continuing to use inspiratory muscle training and I will be monitoring their progress closely during the coming indoor rowing season (and introducing expiratory muscle

training). I am very positive over the training benefits for longer endurance sessions and convinced that older athletes will benefit in some way from the inclusion of inspiratory and expiratory muscle training into their rowing programme.
Individual case studies from my experiment demonstrate the benefits obtained. 49-year-old lightweight Anne Yates increased her inspiratory muscle strength by 55% and reduced her 1609 m rowing time by 5.9 seconds to record a time 0.1 second faster than the existing British record. Anne has continued with the inspiratory muscle training and has now increased her starting muscle strength by 77% and 2k rowing time by over 5 seconds.

Megan Brown 37-year-old heavyweight already had high inspiratory muscle strength but off an improvement of 13.4% reduced her rowing time by 2.5 seconds.

At the other end of the age range 63-year-old Mike Alexander increased his inspiratory muscle strength by 18.5% and rowing time by 0.6 seconds (setting a British record) although in a more recent training session (5 months into using his inspiratory muscle training) he reduced his 1609 m personal best by another 4 seconds.

Anne, Megan and Mike all won gold in there respective categories at the 2004 British Indoor Rowing Championships.

Mike also reports coping much better with his asthma and breathing ‘in the past when I have had a cold I normally use Ventolin 2/3 during the night and probably 3 times during the day. This time I have not used the inhaler at all and today I went back in the gym and did 3x2500 at 2min 5sec pace and 22 spm and my breathing was good’.

How do you train the breathing muscles?

A number of devices are available the best known being the POWERbreathe inspiratory muscle trainers that uses the basic principles of resistance training with an adjustable load which caters for all capabilities and permits progressive training.

The inspiratory muscle trainer induces negative pressure within the thorax (chest) which depends on the opening pressure set on the inspiratory valve. The POWERbreathe describe their device as ‘dumb-bells for your diaphragm which will for a few minutes twice daily, make your inspiratory muscles work harder – thereby increasing their strength and endurance’ and claim that ‘within a few days inspiratory (breathing) muscles will feel stronger and within four weeks lung function, and ultimately performance, will improve’.

Inspiratory and expiratory muscle training should be seen as weight training for the breathing muscles and demands the same care and attention that is given to other training programmes. It needs to be based on scientific measurement of intensity and repetitions, progressive development of intensity over time and specific to the target exercise or training programme so that the optimum effect is produced and therefore should be incorporated into structured periodised training programmes.

Correctly used the benefits of training your breathing muscles can be achieved in as little as four weeks. The breathing muscle training device may also be incorporated into warm up routines to further improve performance.

As a minimum the best way to start inspiratory and expiratory muscle training is to follow the manufacturer's instructions. It is important to follow the correct technique and progressively increase the training load to obtain maximum benefits. As a professional sport and exercise physiologist the author offers a full lung function, inspiratory and expiratory muscle testing service and can design a periodised inspiratory training programme to match other exercise and training requirements. The gains to be made from training the breathing muscles are significant so do not neglect this important aspect of your training.

For help and advice contact Eddie Fletcher on 07711 092377, email: eddie@fletchersportscience.co.uk or visit his website www.fletchersportscience.com

Eddie is an independent Sport and Exercise Physiologist offering a physiological testing and coaching service for rowers, runners, cyclists and swimmers.

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