The importance of respiratory muscle training for inspiratory and expiratory muscles

A white paper on concurrent respiratory muscle training (CRMT) from PowerLung, Inc.

The current body of clinical research work confirms the complex mechanisms that are in place between the respiratory system and the circulatory systems of the human body. This paper attempts to capture that information in a form that addresses the scope of the work and how it applies to the respiratory muscle training uniquely provided by PowerLung products.

Twelve (12) sets of muscles are used in breathing. These muscle groups are used for both inhale and exhale. Principles of strength training in the literature show improved co-ordination and efficiency results by training both agonist and antagonist muscle groups (Sale 1988). Like other sets of muscles, “the respiratory muscles can be trained for improvement in strength, endurance or both.” (Pardy, et al 1988)

Why do you need to train the breathing (respiratory) muscles if you are an active person or athlete?

There is nothing wrong with you. You are breathing. You exercise regularly and you do cardio workouts, wind sprints, and other aerobic activity. Doesn’t this activity train the respiratory muscles? A growing number of clinical studies are now proving that the body's ability to exercise, particularly at high intensities, is significantly limited by the performance of the respiratory system. It does so because during heavy exercise or when you are exercising with maximal effort, four things occur.
**The work of breathing** is increased during exercise and requires up to 15% of the total energy spent in high intensity exercise. The harder the respiratory muscles work, the less blood flows through the legs. This means that the respiratory muscles take blood instead of it being sent to the arms and legs. (St. Croix, et al, 2000; Harms, et al, 2000) Therefore, anything that lessens the respiratory muscle workload means more blood (which contains oxygen, sugar for the muscles and gets rid of lactate and carbon dioxide) can flow to the legs and arms during intense exercise.

Research clearly demonstrates that respiratory muscle training improves both the strength AND endurance capacity of the inspiratory AND expiratory muscles.

**Respiratory Muscle Fatigue.** The respiratory muscles are subject to fatigue just like other muscles in the body and this fatigue can reduce blood flow to the peripheral muscles (Sheel, et al 2001). Recent research demonstrates that a single 200-meter swim can cause significant respiratory muscle fatigue as measured by maximal inspiratory pressure. The impact of this on the athlete is the impact on the ability to inhale adequately. The athlete may perceive breathing is very difficult causing them to work even harder to breathe and thus causing problems related to the work of breathing.

Respiratory muscle fatigue has been shown to negatively affect the respiratory system demands to generate the required amount of pressure necessary to provide for adequate ventilation (Lomax and McConnell, 2003).

**Physiological stress.** Most well trained individuals show significant physical stress during exercise. This physiological stress can have detrimental effects on oxygen uptake (Dempsey and Wagner, 1999).

**The sensation of breathlessness.** Breathing discomfort, dyspnoea, may ultimately determine an individual athlete's exercise tolerance because it can prevent the development of respiratory muscle fatigue (Altose et al., 1985) because it limits an athlete's ability to continue to perform at the required intensity. When the sensation of breathlessness and breathing discomfort occurs during high intensity exercise it may be the ultimate exercise-limiting factor.

The importance of this is best demonstrated by two swimmers who are neck and neck at the end of the race both dealing with the urge to breathe. The one who breathes first usually loses. Decreases in the sensation of breathlessness are associated with increases in swimming speed during taper as documented by Wells, et al.
The respiratory muscles can limit exercise performance and endurance.

In a 2000 study, Prefaut, et al demonstrated that all of the above conditions could result in the limitation of exercise performance. Respiratory muscle training can be effective in addressing the limitations of the respiratory system during exercise (recently reviewed in Sheel (2002). Research in this area has demonstrated that respiratory muscles, just like other skeletal muscles, adapt to specific respiratory muscle training and to whole body exercise training in relation to pulmonary function, respiratory muscle endurance, and maximal strength. Studies have also shown improvements in exercise endurance (Boutellier et al., 1992; Boutellier and Piwko, 1992; Boutellier, 1998; Spengler et al., 1999; Markov et al., 2001; Stuessi et al., 2001 Research results indicate that specific respiratory muscle training, in addition to normal exercise training, may reduce sensitivity to chemoreceptors. It is believed this occurs because of the repeated exposure to high levels of breathing present during endurance exercise training (McMahon et al., 2002).

Because of the more active nature of inspiration in the breathing process, most research has focused on the effects of inspiratory muscle training only. Documentation suggests the expiratory muscles may not contribute significantly to the work of breathing while an individual is at rest. The trend to focus exclusively on inspiratory is changing because of recent research findings. The findings show the expiratory muscles become actively involved at high exercise intensities. Because high ventilation rates are required to maintain exercise intensity and airway flow during this period becomes “turbulent” more effort is required of the muscles used in exhalation. Recent research by Derchak et al. (2002) shows that high-intensity contractions of expiratory muscles to the point of task failure caused a time-dependent sympatho-excitation and increases in mean arterial pressure. This suggests that expiratory muscle fatigue may also result in constriction of blood vessel in the limbs during exercise.

A principle in the strength training literature that training both agonist and antagonist muscle groups results in improved neuromotor co-ordination and movement efficiency (Sale, 1988) has not, until recently been applied to the respiratory muscles and there has been no research on the effect of concurrent inspiratory and expiratory muscle resistive training despite these existing principles in the literature. In a recent study, Wells, et al, evaluated the effect of concurrent inspiratory and expiratory muscle training (CRMT) on pulmonary function and on the strength and endurance of the respiratory muscles to apply the strength training literature to the respiratory muscles.

the importance of including expiratory muscles in a respiratory muscle training program.
As the body of literature grows it continues to support the benefits of respiratory muscle training for the athlete. Further, the literature no longer suggests the benefits are restricted to inspiratory muscles. Instead, as shown in this paper the research substantiates the principles of training the inspiratory AND expiratory muscles for strength, power and endurance can provide the athlete with the same benefits this type of training provides to other skeletal muscles.

We built PowerLung to solve a problem: the ventilatory system limits human performance.

acknowledgement
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sources


