

PERFORMANCE GAINS FOLLOWING RESISTANCE BREATHING EXERCISES: SINGLE SUBJECT CASE STUDY

[Bill Misner, Ph.D.](#)¹

The USA Olympic development invests significant funds for determining how to improve athletic performance by a single percent. Periodic strength, endurance, and volume of maximal oxygen exchange are foundational to performance gain.

. It is generally concluded from a vast array of sports science literature that exercise intensity is required to increase muscle fiber growth quality, while prolonging duration produces increased cellular enzymes, mitochondria cells, and vascular proliferation^{2 3 4}. Exercise to advance pulmonary muscle efficiency is a contributing factor in performance but is seldom applied to training interventions

One hypothesis advocates adaptive inspiration and expiration muscle stress interventions improve the same adaptations required by locomotion muscle groups^{5 6} resulting in performance gain. The protocol for expiration and inspiration breath-resistance may improve the muscular component of breathing efficiency after a resistance load is repeatedly applied⁷. End-expiratory lung volume loading (ERL) increases lung volume by 0.20 and 0.24 liters during rest and exercise⁸. The use of breathing resistance exercise in patients with Chronic Obstructive Pulmonary Disease (COPD) reduces symptomatic air exchange difficulties. COPD patients trained for one half hour daily for 4 weeks, doing forced breathing exercises into a simple device, where they inspired against a resistance load forcing breaths. After 4 weeks this resistance load was increased, and 4-weeks training were repeated using the increased load to breathing muscles. All patients improved with this form of training, i.e. higher resistances increasingly were tolerated without signs of fatigue

¹ Director Research & Product Development, EMG Whitefish, Montana 1-800-336-1977.

² Cronin J, Sleivert G. Challenges in understanding the influence of maximal power training on improving athletic performance. *Sports Med.* 2005;35(3):213-34. Review.

³ Hoff J, Gran A, Helgerud J. Maximal strength training improves aerobic endurance performance. *Scand J Med Sci Sports.* 2002 Oct;12(5):288-95.

⁴ Adhihetty PJ, Irrcher I, Joseph AM, Ljubicic V, Hood DA. Plasticity of skeletal muscle mitochondria in response to contractile activity. *Exp Physiol.* 2003 Jan;88(1):99-107. Review.

⁵ McConnell AK, Romer LM. Respiratory muscle training in healthy humans: resolving the controversy. *Int J Sports Med.* 2004 May;25(4):284-93. Review.

⁶ Holm P, Sattler A, Fregosi RF. Endurance training of respiratory muscles improves cycling performance in fit young cyclists. *BMC Physiol.* 2004 May 6;4(1):9.

⁷ Carra J, Candau R, Keslacy S, Giolbas F, Borrani F, Millet GP, Varray A, Ramonatxo M. Addition of inspiratory resistance increases the amplitude of the slow component of O₂ uptake kinetics. *J Appl Physiol.* 2003 Jun;94(6):2448-55. Epub 2003 Feb 21.

⁸ Spahija JA, Grassino A, 1996. Effects of pursed-lips breathing and expiratory resistive loading in healthy subjects. *J Appl Physiol* May;80(5):1772-84.

and failure. In addition most patients claimed that training had helped them with daily living; they were able to do more without getting short of breath. The device also increased expectoration, possibly owing to the effect of the small expiratory resistance⁹.

In healthy normal non-COPD subjects, elite swimmers are, by nature of the sport, forced to breath harder than subjects on land. Enlarged lung capacity is a sports-specific side effect from competitive swimming. Researchers confirm that swimmers achieve greater lung volumes than either runners or sedentary subjects.

ENLARGED LUNG VOLUMES IN SWIMMERS ARE NOT DUE TO:

- (1) Inspiration muscle strength**
- (2) Differences in height**
- (3) Fat free mass**
- (4) Alveolar distensibility**
- (5) Age**
- (6) Sternum length**
- (7) Chest depth**
- (8) Increased size alveoli**

They concluded that swimming exercise forces increased inspiration and expiration stress, developing greater chest volume, increased number of alveoli, or number of air sacs per volume lung tissue¹⁰.

QUESTION: DOES AIRWAY MUSCULATURE AFFECT PERFORMANCE?

Sports specific performance gains from the effect of periodic anaerobic exercise are therefore expected in healthy-normal athletes on all muscle groups including those muscles whose role it is to impact efficient inspiration and expiration. In the absence of performance-enhancing anaerobic training, performance gains from training will cease with no progress at a stagnant plateau. What would occur if anaerobic training to the large locomotion muscles were limited to 1 timed 2-3 minute all-out effort every 7-days but the airway musculature was anaerobically trained 6 days out of every 7 days for the same 2-3 minute duration? During the later 6-days, only aerobic training was permitted, to determine the effect of airway anerobic resistance training on performance.

METHODS

⁹ Andersen JB, Dragsted L, Kann T, Johansen SH, Nielsen KB, Karbo E, Bentzen, 1979. Resistive breathing training in severe chronic obstructive pulmonary disease. A pilot study. Scand J Respir Dis Jun;60(3):151-6.

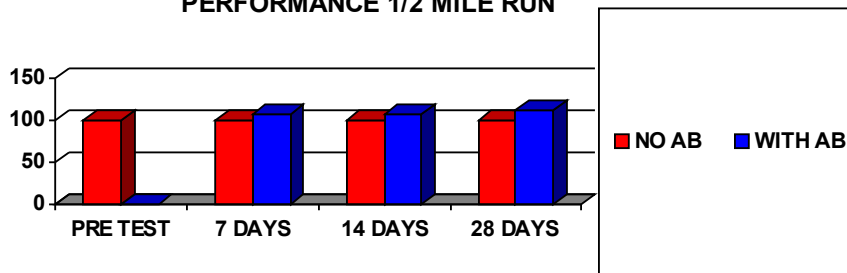
¹⁰ Armour J, Donnelly PM, Bye PT, 1993. The large lungs of elite swimmers: an increased alveolar number? Eur Respir J 1 Feb;6(2):237-47.

To test this hypothesis, following 90-days base endurance training, a timed straight point-to-point half-mile road course timed run at maximal effort was measured. Nineteen (19) endurance-only training sessions¹¹ followed the timed run with NO intensity speed work during the 28-day period. Training during the test consisted of 6, 10, and 20-mile distance runs, limited to 6 training days each week. The “Sports Breather” resistance exercises were performed prior to each training session. These inhale-exhale resistance exercises consisted of 3-5 sets of ten repetitions, which taxed inhaling and exhaling musculature to fatigue. Four timed ½-mile distance runs were conducted once per week for consecutive 4 weeks to assess performance gain or loss.

RESULTS

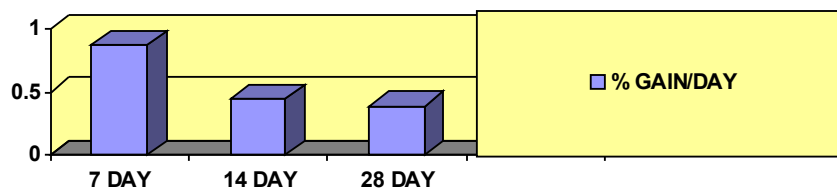
The subject’s pre-test time was 3:06:00 for half-mile run (minutes:seconds:seconds fraction). Following 19 training sessions, performance improved to 2:45.31, representing an 11.1% performance gain. The only variable to account for this improvement was the 19 sessions utilizing the inhale-exhale resistance breathing exercises. Note the gradual rate of improvement in anaerobic ½ mile run performance in Table I:

TABLE I. AIRWAY RESISTANCE EXERCISES IMPROVE PERFORMANCE 1/2 MILE RUN



The first 7 days application of resistance breathing exercises produced the greatest rate of performance gain of 0.87% gain per day average. The 14- and 28-day periods produced descending rates improvement of 0.45%/day and 0.39%/day, respectively. This indicates the first 7 days airway resistance training achieved the most rapid rate of performance gain, though additional gains were added on during the following 21 days¹².

AVERAGE DAILY PERFORMANCE GAIN



¹¹ Endurance training consisted of 6-20 mile runs at a 75% Max effort determined by heart rate formula, (Karvonen formula 220-age=100% VO² Max). No speed work or strength workouts were performed other than resistance breathing with Sports Breather.

¹² The subject tested was the author, which limits objective interpretation of these results.

DISCUSSION

It needs be emphasized that the subject did not engage in any other form of speed or strength training, nor did he alter weekly mileage from prior to this test and including during the 4-week experimental trial. Sport science consensus dictates the sport specificity training must be periodically increased in order to improve rate of athletic performance. Repetitive endurance base training without periodic quality speed work or strength training predictably does not achieve performance gains¹³. The only variable during the test period to account for these measured performance gains was resistance-breathing exercise. A single subjects' 11.1% performance-gain following 28-days of airway resistance breathing exercise suggests:

- Performance gains could have occurred unexplainably as a property of timing**
- Performance gains could have occurred had the subject employed the same sprint training**
- Performance gains could have occurred solely as a result of the adaptations imposed by inspiration and expiration musculature**

Since this experimental study determined the positive effect of resistance breathing exercises on one subject, application to improve endurance performance in other athletes is not an assumed conclusion. Measurement of changes in the efficiency of pulmonary oxygen stress might further elucidate the proposed mechanism of action. Further research is needed with more endurance and sprint athletes, measuring a variety of physiologic and metabolic endpoints, to determine if the results of this study prevail and, if so, the degree of benefits achieved.

ACKNOWLEDGEMENTS: A single "Sports Breather™" unit was supplied courtesy of the [manufacturer](#), Health Fitness Center.

DISCLOSURE: This paper reports a single case study independent of remunerative compensation from the Health Fitness Center or those associated with marketing or manufacture of "The Sports Breather™".

¹³ Noakes TD, 1991. Sports science Consensus dictates sport-specificity principle that to improve existing performance, athletes must impose increased training stress above present training level. The Lore of Running. Leisure Press, Champaign, IL, 18-23.