

EFFECTS OF INSPIRATORY MUSCLE TRAINING UPON TIME TRIAL PERFORMANCE IN COMPETITIVE CYCLISTS

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There is considerable interest in the use of specific inspiratory muscle training (IMT) to improve exercise performance. Several early studies failed to demonstrate such an effect in healthy individuals (see Boutellier, 1998 for review) while more recent studies have reported significant improvements (e.g. Spengler et al., 1999; Volianitis et al., in press). In view of these discrepancies, the purpose of the present study was to evaluate the effects of IMT upon prolonged endurance performance in competitive cyclists using valid and reliable performance measures.

Using a double blind placebo-controlled design, 16 male cyclists (mean \pm SEM $\dot{V}O_{2\max}$ 64 ± 2 ml \cdot kg $^{-1}\cdot$ min $^{-1}$) were assigned randomly to either an experimental (IMT) or sham-training control (placebo) group. Pulmonary function, maximal dynamic inspiratory muscle function (e.g. maximum inspiratory mouth pressure, flow rate and power output), and the physiological and perceptual responses to maximal incremental cycling were assessed. On separate occasions simulated time trial performance (20 and 40 km) was quantified as the time to complete pre-set amounts of work based on the maximal power output achieved during incremental exercise (Jeukendrup et al., 1996). Following completion of baseline measures, the IMT group performed 30 dynamic inspiratory efforts twice daily for 6 wk against a pressure-threshold load equivalent to the maximum inspiratory muscle power output (MIMPO). The placebo group performed 60 slow protracted breaths once daily, for 6 wk, at a pressure threshold equivalent to 25% MIMPO, a protocol known to elicit negligible changes in inspiratory muscle function. All baseline measures were repeated following the intervention.

Following the intervention all measures of inspiratory muscle function improved in the IMT group ($P \leq 0.05$, mixed factorial ANOVA), but not the placebo group. During incremental exercise the IMT group experienced a mean reduction in the perception of respiratory and peripheral effort (Borg CR10; $16 \pm 4\%$ and $18 \pm 4\%$, respectively, c.f. baseline, $P \leq 0.01$). Following intervention, the IMT group completed the simulated 20 and 40 km time trials faster than the placebo group (66 ± 30 and 115 ± 38 s, respectively; $P = 0.025$ and 0.009). This represents improvements of 3.8 ± 1.7 and $4.6 \pm 1.9\%$ for 20 and 40 km time trial performance, respectively. The likely ranges of the true effect of the intervention on the average subject (i.e., 95% confidence intervals) included enhancements of almost twice these magnitudes (-0.7 to -6.9% and -0.8 to -8.4% , 20 and 40km, respectively). Between group differences were most pronounced during the later stages of the time trial rides.

These data support recent evidence that specific IMT attenuates the physiological and perceptual responses to maximal incremental exercise (Volianitis et al., in press). Furthermore, the present study provides new evidence of substantial performance enhancements in competitive cyclists following IMT.

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