The Effect on Performance of Replacing Running with Two Modes of Cross Training in Competive Runners

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Abstract

Previous research has shown that runners who cross-train can maintain physiological parameters such as maximum oxygen consumption (VO_2max), but has been equivocal about the ability to maintain competitive running performance while cross-training. In this study a group of high school cross country runners was tested immediately after their season on a treadmill for VO_2max, lactate threshold, and running economy at sub-maximal speeds. They also performed a 3000-meter time trial on a track. Following the tests, the runners were randomly assigned to one of two cross-training groups (N=17, 12 male, 5 female), the first using elliptical exercise trainers (ET), and the second using stationary bicycles (SB), and given assigned workouts to replace all running. After five weeks of cross-training, the treadmill and performance tests were repeated. A control group of runners (RUN) (N=9, 6 male, 3 female) completed the same tests but continued normal off-season run training in the interim. Post-study 3-km time trials were significantly slower than the ET group (47.7± 11.3 sec) and SB group (42.7 ± 6.3 sec), while the RUN group showed non-significant improvements (9.4 ± 8.3 sec). No significant changes were found in any group for VO_2max or lactate threshold.

Introduction

Cross-training, or training with modes of exercise different than the primary mode used in competition, is widely used by runners to reduce the risk of repetitive-impact injuries, or to maintain fitness when an injury prevents running. Previous studies have shown very little difference between running and cross-training of comparable duration and intensity with regard to VO_2max. Most results have been inconclusive on the effects on competitive performance, due to small sample sizes and the failure to use competitive runners as subjects.

This study also tracked changes in running economy after different types of training. Among runners of a similar competitive level, economy, or the energy cost of running a given pace, is a greater predictor of performance than VO_2max. Economy may be negatively affected when run training is reduced or eliminated. This is especially true when cycling on a road or stationary bike (SB) because the exercise is done in a seated position. Elliptical training (ET) has a potential advantage compared to SB in that the individual is in an upright position, similar to running, that requires support of the body weight. This research was designed to identify any the performance effects of ET and SB compared to run training (RUN), and to investigate whether either mode of cross-training effects running economy.

Table 1: Subject Characteristics

	ET	SB	RUN
Gender	6 m, 4 f	6 m, 1f	6 m, 3 f
Age (years)	15.4 ± 0.3	16.5 ± 0.3	17.4 ± 0.5
Weight (kg)	57.3 ± 3.0	60.6 ± 2.2	62.6 ± 2.4
Height (m)	1.67 ± 0.02	1.72 ± 0.03	1.72 ± 0.03
Body Fat (%)	11.3 ± 1.6	9.9 ± 0.9	11.0 ± 1.9
BMI	20.3 ± 0.6	20.4 ± 0.5	21.2 ± 0.6
VO_2 Max (ml/kg/min)	57.0 ± 2.4	59.2 ± 2.1	60.0 ± 1.8
5km best (sec)	1240 ± 27	1212 ± 42	1147 ± 41

Data are presented as means + SEM. All values are from pre-study testing. BMI=body mass index. Body fat from 3-site skinfold.

Methods

TESTING

In the first week after the conclusion of their competitive season, subjects reported to the Human Performance Lab. Height, weight, and body fat percentage were measured. After warmup subjects completed a graded exercise test on a treadmill. The first two stages of the test were four minutes each, run at paces equal to 75% and 90%, respectively, of the subject's best 5-km pace. Later stages were two minutes each, with the treadmill speed increased by 7.5% of 5-km pace in each stage until the subject was unable to continue. VO_2 and blood lactate levels were measured in the final minute of each stage. In the first two stages stride length was also determined by measuring the time for 30 strides.

A 3000-meter time trial was run on an indoor track 1-3 days after the treadmill tests. Subjects were grouped with others of similar ability and/or assigned non-subject pacers to help insure a maximum effort. All tests were repeated at the conclusion of the training period, with subjects following the same protocol as used in their initial tests.

TRAINING

After the initial 3000m time trial, the subjects began a 5-week training period. All subjects were instructed to train using their assigned mode (ET, SB, or RUN). Subjects with an individual training plan designed to replicate the volume and intensity of normal off-season training for distance runners. Training was done four to six days per week, for 45-60 minutes each day, with exact volumes based on reported in-season training levels. Weekly training programs included one day with long intervals at an effort corresponding to lactate threshold, and one day with 10-second "sprints". The remaining training days each week were continuous workouts at a pace/effort of a typical distance run during cross country season.

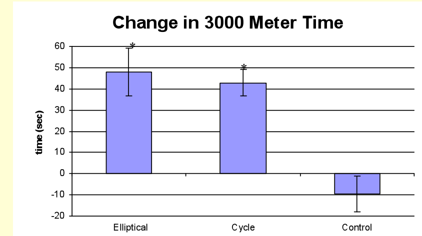
Table 2: Experimental Results

Changes from Pre-training to Post-training Tests

	ET	SB	RUN
3km time (sec)	47.7±11.3*†	42.7±6.3*†	-9.4 ± 8.3
VO_2 max	0.8 ± 0.9	-0.6 ± 1.3	-0.2 ± 0.6
Stage 1 VO_2	-0.3 ± 1.3	-0.1 ± 1.3	0.2 ± 0.8
Stage 1 SL (m)	0.01 ± 0.02	0.09±0.03†	0.06 ± 0.02†
Stage 1 Lactate	-0.3 ± 1.4	0.3 ± 1.3	0.0 ± 0.4
Stage 2 VO_2	0.3 ± 0.5	1.2 ± 1.2	0.9 ± 0.5
Stage 2 SL (m)	0.03 ± 0.02	0.10±0.05	0.06 ± 0.02†
Stage 2 Lactate	-2.3 ± 1.2	-0.9 ± 1.4	1.2 ± 1.2
Stage 3 VO_2	1.4 ± 1.0	1.5 ± 0.6†	0.9 ± 0.7
Stage 3 Lactate	2.4 ± 1.9	4.3 ± 3.4	0.4 ± 1.3
Stage 4 VO_2	1.7 ± 1.5	-1.7 ± 3.3	-0.1 ± 0.9
Stage 4 Lactate	1.0 ± 1.3	0.8 ± 2.4	0.7 ± 0.8
Body Fat %	1.0 ± 0.4	1.9±0.5†	0.8 ± 0.5

Data are presented as means ± SEM. SL = stride length. * Indicates significance (p<0.05) between experimental group and control. †Indicates significance (p<0.05) between pre- and post-training values for the indicated group. VO_2 values in $ml \cdot kg^{-1} \cdot min^{-1}$. Lactate values in $mmol \cdot L^{-1}$.

Effect of Cross-Training on Performance



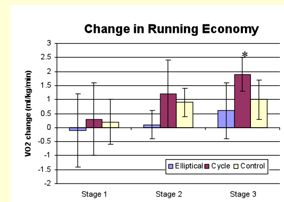
*- significantly different from control (p<0.01)

Discussion

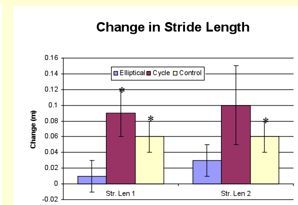
ET and SB were significantly slower in the post-study time trial. The time change between time trials was significantly different than that in RUN, but there were no differences between ET and SB. The improvement RUN was not statistically significant (p = 0.289). There were no significant changes in any group in VO_2max or blood lactate levels at sub-maximal paces, two of the most important variables that can affect distance running performance.

Running economy changes were generally insignificant. SB showed statistically worse economy on stage 3 in the post-training test. But there were not statistically meaningful differences between groups, as all groups showed slight decreases in economy on stages 2 and 3. The cycling group had a statistically longer stride on stage 1 post-training, and the control group had a longer stride after stages 1 and 2. In this case there was not a statistical correlation between longer stride and economy. There was an increase in body-fat percentage across all groups, but this did not correlate with performance or economy.

Economy at Different Paces



*- significant change from pre-study (p<0.05)



*- significant change from pre-study (p<0.05)

Conclusions

The data show a significant decline in running performance after five weeks of cross-training using either elliptical machines or stationary bike. Running controls saw a non-significant improvement in performance. No changes in VO_2max were seen in any group. There was a trend toward lower economy after cycle cross-training, including a significant increase in stride length at 75% of 5km race pace and a significant decrease in running economy at 97.5% of 5km race pace.

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