The effect of high-intensity interval training on stroke volume and endurance performance in trained endurance athletes

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Introduction

Endurance performance and maximal oxygen uptake (VO₂ max) can improve in highly trained athletes following a strategic high-intensity training (HIT) protocol. Tapering training prior to competition can also give a performance advantage. It has been suggested that this improvement in performance is significantly affected by an increase in stroke volume, which in turn improves oxygen delivery to exercising muscles. However, changes in maximal stroke volume (SVmax) in response to HIT and tapering in trained athletes has not previously been examined. Thus, the purpose of this study was to compare the effects of two training protocols, HIT and low intensity training (LIT) on changes in SVmax, plasma volume (PV), VO₂ max, and endurance performance variables.

Methods

Twelve trained male cyclists (mean ± SD; age = 25 ± 6 yr; weight = 74.6 ± 3.8 kg; VO₂ max = 61.7± 3.6 mL•kg⁻¹•min⁻¹) volunteered for this study. There were four test weeks separated by high volume training (HVT) (4 days – 3 hrs per day), high or low intensity training (2 weeks), and finally a taper (2 weeks). During each test week, the cyclists performed: 1) a progressive cycle test to measure VO₂ max, cardiac output (Q), maximum heart rate (HRmax), and peak aerobic power output (PAPO); 2) a lactate minimum test; 3) a 20 km time trial (TT); 4) progressive exercise echocardiography test to PAPO; and 5) an endurance ride at 110% lactate minimum power output (LMPO). In addition, hemoglobin and hematocrit were measured. Cardiovascular measures were determined by open-circuit acetylene breathing. After the initial HVT block, the group was randomly assigned to HIT (n = 6) or LIT (n = 6). All subjects completed the same total volume of work 6 days per week, the HIT group completed 8 x 2.5 min at PAPO with rest to 65% HRmax twice per week, the rest of the training for both groups was done at aerobic threshold intensity.

Results

SVmax increased for all subjects following the HVT and subsequently decreased when HIT and LIT were implemented (p = 0.002). HRmax followed the inverse pattern (p = 0.001) (see Figure 1.0) and cardiac output only mildly increased following the volume training (p = 0.03). Hematocrit decreased following HVT and then increased during HIT and LIT (p = 0.001). LMPO increased 5% for all subjects following HVT, then increased a further 9% (275 to 297 W) in the HIT group, but did not change for the LIT group (260 W) (see Figure 2.0). PAPO increased from 425 W after HVT to 460 W post-taper for the HIT group, whereas, the LIT group did not change PAPO until the effect of the taper (405 W to 425 W). Time trial performance increased linearly for both groups (p < 0.001), peaking during the fourth test interval.

Discussion/Conclusion

SV increased with HVT and decreased thereafter with both HIT and LIT. As expected, hematocrit and HRmax followed the inverse pattern to SV. Although there was a decline in SV, LMPO increased significantly following HIT, with no change for the LIT group. The taper produced superior PAPO and TT performance, while LMPO was maintained at previously attained levels after both training conditions. This study has demonstrated that an acute HIT strategy at PAPO enhanced LMPO, while a taper sequence improved performance requiring max effort for both groups and that these training strategies can alter performance despite a decline in SVmax.

References