Physiological and Performance Adaptations to High-Intensity Interval Training

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Introduction

High-intensity interval training (HIIT) refers to exercise that is characterized by relatively short bursts of vigorous activity, interspersed by periods of rest or low-intensity exercise for recovery. HIIT is infinitely variable, and the specific physiological adaptations induced by this form of training are likely determined by many factors including the mode and precise nature of the exercise stimulus, i.e. the intensity, duration and number of intervals performed, as well as the duration and activity patterns during recovery.

Adaptations to Low-Volume HIIT in Untrained and Recreationally Active Individuals

In untrained and recreationally active individuals, short-term HIIT is a potent stimulus to induce physiological remodeling similar to traditional endurance training despite a markedly lower total exercise volume and training time commitment [1, 2]. The most common model employed in low-volume HIIT studies has been the Wingate Test, which consists of 30 s of ‘all-out’ cycling on a specialized ergometer. Wingate-based HIIT typically consists of 4–6 work bouts separated by a few minutes of recovery, for a total of 2–3 min of intense exercise spread over a training session that lasts ~20 min. As little as 6 sessions of this type of training over 14 days, totaling ~15 min of all-out cycle exercise within total training time commitment of ~2.5 h, is sufficient to dramatically improve exercise capacity and enhance skeletal muscle oxidative capacity [1, 2]. Studies that have directly compared responses of Wingate-based HIIT versus a much higher volume of traditional endurance training have revealed similar improvements in VO₂max and various markers of skeletal muscle and cardiovascular adaptation despite large differences in weekly training volume and time commitment.
Effect of HIIT in Highly Trained Individuals

In comparison to untrained and recreationally active subjects, much less is known about the response of highly trained individuals to HIIT. Although typically an integral component of training programs for the enhancement of athletic performance, research into the unique effects of HIIT on the performance of well-trained individuals is sparse [3]. Nonetheless, there is evidence to suggest that inserting a relatively short period of HIIT into the already high training volumes of well-trained athletes can further enhance performance [3–5]. Most studies in this regard have examined the effect of replacing a portion (typically ~15–25%) of base/normal training with HIIT (usually 2–3 sessions per week for 4–8 weeks). The precise nature of the HIIT stimulus has varied from repeated intervals lasting up to 5 min at an intensity eliciting ~80% VO$_2$max to 30-second efforts at an all-out pace or power outputs corresponding to ≥175% of VO$_2$max. Studies on well-trained cyclists have examined the effect of replacing 15% of their normal base training with HIIT, which consisted of 6–8 repetitions x 5 min at an intensity that elicited 80% of each subject’s peak power output, interspersed with 60 s of recovery. After 6 sessions of HIIT over a 4-week period, the cyclists improved their peak power and speed during a 40-km time trial that translated into improved performance (56.4 vs. 54.4 min).

The mechanisms responsible for the observed performance improvements after HIIT in highly trained individuals are likely different compared to less trained subjects. Whereas rapid increases in skeletal muscle oxidative capacity are observed after a short period of low-volume HIIT in untrained and recreationally active subjects, several weeks of HIIT does not further increase the maximal activity of mitochondrial enzymes in highly trained individuals. While the mechanisms responsible remain to be fully elucidated, it has been proposed that a polarized approach to training, in which ~75% of total training volume be performed at low intensities, with 10–15% performed at very high intensities, may be the optimal training intensity distribution for elite athletes who compete in intense endurance events [5].

References

