Nutritional Strategies to Support Adaptation to High-Intensity Interval Training in Team Sports

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Introduction

Team sports are characterized by intermittent high-intensity activity patterns. Typically, play consists of short periods of very intense or all-out efforts interspersed with longer periods of low-intensity activity, and training programs are at least partly designed to simulate this activity pattern. The intermittent nature of this type of activity requires a high capacity for both aerobic (oxidative) and anaerobic (non-oxidative) energy provision. Fatigue is a complex, multi-factorial process, but intense intermittent exercise performance can potentially be limited by reduced availability of substrates stored in skeletal muscle (e.g. glycogen) and/or metabolic by-products associated with fuel breakdown.

Skeletal Muscle Adaptation to High-Intensity Interval Training

High-intensity interval training (HIT) is infinitely variable, and the specific physiological adaptations induced by this form of training are determined by numerous factors including the precise nature of the exercise stimulus, i.e. the intensity, duration and number of intervals performed as well as the nature and duration of the recovery periods [1, 2]. Interval intensity is a critical variable that can be quantified in various ways, but HIT generally refers to repeated efforts that correspond to ≥90% of maximal heart rate or ≥85% of peak oxygen uptake (Vo₂peak). Numerous short-term HIT protocols – mainly cycling or running models – have been shown to induce adaptations in skeletal muscle that enhance the capacity for both oxidative and non-oxidative metabolism [1]. Much
of this work has been conducted on recreational athletes, and while short-term HIT can also improve performance in high-trained subjects, the precise mechanisms responsible are less clear [2].

**Potential Nutritional Strategies to Alter HIT Adaptation**

Guidelines are available regarding the appropriate selection of food and fluids, timing of intake, and supplement choices, including recommendations by sports nutrition experts specifically tailored to team sport players [3, 4]. The general consensus is that athletes should consume a high-carbohydrate diet (6–12 g/kg per day) in order to meet the energy demands of training and competition. However, there is also evidence to suggest that periodic training with reduced carbohydrate availability may augment HIT-induced adaptations in skeletal muscle, although this does not appear to translate into improved performance. Nutrient availability is also a potent modulator of many acute physiological responses to exercise, including various molecular signaling pathways that are believed to regulate cellular adaptation to training [5]. Several nutritional strategies have also been shown to acutely alter metabolism and enhance intermittent high-intensity exercise performance [3, 4]. However, relatively little is known regarding the effect of chronic interventions, and whether supplementation over a period of weeks or months augments HIT-induced physiological remodeling and promotes greater performance adaptations. Theoretically, a nutritional intervention could augment the adaptation to HIT by (1) improving energy metabolism during acute high-intensity exercise (e.g. enhancing mitochondrial function), which could facilitate greater total work and an enhanced chronic training stimulus; (2) promoting some aspect of the acute molecular response to exercise (e.g. by increasing gene expression in recovery), which could lead to enhanced physiological adaptations over time, or (3) some combination of these two factors. A theoretical model by which nutritional manipulation could augment adaptation to HIT by ‘optimizing’ the effect of successive training bouts is shown in figure 1.

Several nutritional strategies have been shown to acutely alter metabolism and enhance intermittent high-intensity exercise performance, but little is known regarding the effect of chronic interventions. Limited evidence suggests that two supplements – sodium bicarbonate and β-alanine – could potentially augment training adaptations by altering muscle-buffering capacity. However, training studies are warranted to determine whether supplementation with these compounds over weeks or months augments HIT-induced physiological remodeling and/or promotes greater performance adaptations in humans.
Fig. 1. Theoretical model by which nutritional manipulation could augment adaptation to HIT by ‘optimizing’ the effect of successive training bouts. While nutrient availability is a potent modulator of many acute responses to exercise, at present there is little direct evidence to support the model (i.e. in terms of specific physiological adaptations to HIT that are altered by chronic nutritional manipulation).

References