Nutritional Strategies to Modulate the Adaptive Response to Endurance Training

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Skeletal muscle carbohydrate availability exerts profound effects on resting fuel metabolism and patterns of fuel utilization during exercise, as well as acute regulatory processes fundamental to cell signaling and gene expression. Independent of prior training status, short-term (3–10 weeks duration) endurance-based training programs in which a portion (typically ~50%) of all workouts are commenced with low muscle glycogen and/or low exogenous glucose availability augment training adaptation (i.e. increase the maximal activities of several enzymes involved in carbohydrate/fat transport and metabolism and promote mitochondrial biogenesis) to a greater magnitude than when all workouts are undertaken with normal or high carbohydrate availability [for review, see 1]. While the precise mechanisms underlying these training-nutrient interactions have not been completely elucidated, exercise sessions commenced with low muscle glycogen result in increased cellular stress (i.e. reduced levels of high energy phosphates and an elevated concentration of AMP) resulting in a greater activation of the AMP-activated protein kinase (AMPK) [2]. The AMPK has several metabolic functions [for review, see 3] and is partly, but not entirely, responsible for the metabolic responses of muscle to acute exercise bouts. The AMPK also appears to be responsible for many of the long-term metabolic adaptations to endurance training, particularly the activation of the peroxisome proliferator-activated receptor gamma coactivator-1a, a transcriptional coactivator involved in stimulation of mitochondrial biogenesis. However, while low carbohydrate availability amplifies some of the adaptive responses to exercise in trained muscles, high-intensity workouts commenced with low muscle glycogen stores can only be performed at a reduced power output or speed compared to when the same sessions are started with normal or high-glycogen availability: on average, the work rates sustained during high-intensity endurance training commenced with low-glycogen availability
are reduced by ~8% [4, 5]. The reduction in power output is because it is not possible to perform high-intensity work with low muscle glycogen stores. Accordingly, athletes perceive the effort associated with intense exercise to be substantially higher, at least during their initial (1–2 weeks, 3–6 sessions) exposure to ‘train low’. However, after several weeks of this regimen, the work rates sustained by highly motivated endurance-trained athletes are not significantly different whether high-intensity workouts are performed in the face of low- or high-glycogen. Accordingly, it is recommended that coaches and sport scientists make informed decisions as to the precise timing of train-low strategies in the periodized training programs of their athletes such that they attain maximal adaptations that will ultimately drive the phenotype-specific characteristics required to enhance performance capacity in these individuals.

References