Scientific basis and practical aspects of creatine supplementation for athletes.

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Abstract: A large number of studies have been published on creatine supplementation over the last decade. Many studies show that creatine supplementation in conjunction with resistance training augments gains in muscle strength and size. The underlying physiological mechanism(s) to explain this ergogenic effect remain unclear. Increases in muscle fiber hypertrophy and myosin heavy chain expression have been observed with creatine supplementation. Creatine supplementation increases acute weightlifting performance and training volume, which may allow for greater overload and adaptations to training. Creatine supplementation may also induce a cellular swelling in muscle cells, which in turn may affect carbohydrate and protein metabolism. Several studies point to the conclusion that elevated intramuscular creatine can enhance glycogen levels but an effect on protein synthesis/degradation has not been consistently detected. As expected there is a distribution of responses to creatine supplementation that can be largely explained by the degree of creatine uptake into muscle. Thus, there is wide interest in methods to maximize muscle creatine levels. A carbohydrate or carbohydrate/protein-induced insulin response appears to benefit creatine uptake. In summary, the predominance of research indicates that creatine supplementation represents a safe, effective, and legal method to enhance muscle size and strength responses to resistance training.

The effects of creatine supplementation on muscular performance and body composition responses to short-term resistance training overreaching.

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Abstract To determine the effects of creatine supplementation during short-term resistance training overreaching on performance, body composition, and resting hormone concentrations, 17 men were randomly assigned to supplement with 0.3 g/kg per day of creatine monohydrate (CrM: n=9) or placebo (P: n=8) while performing resistance exercise (5 days/week for 4 weeks) followed by a 2-week taper phase. Maximal squat and bench press and explosive power in the bench press were reduced during the initial weeks of training in P but not CrM. Explosive power in the bench press, body mass, and lean body mass (LBM) in the legs were augmented to a greater extent in CrM ( P<or=0.05) by the end of the 6-week period. A tendency for greater 1-RM squat improvement ( P=0.09) was also observed in CrM. Total testosterone (TT) and the free androgen index (TT/SHBG) decreased in CrM and P, reaching a nadir at week 3, whereas sex hormone binding globulin (SHBG) responded in an opposite direction. Cortisol significantly increased after week 1 in CrM (+29%), and returned to baseline at week 2. Insulin was significantly depressed at week 1 (-24%) and drifted back toward baseline during weeks 2-4. Growth hormone and IGF-I levels were not affected.
Therefore, some measures of muscular performance and body composition are enhanced to a greater extent following the rebound phase of short-term resistance training overreaching with creatine supplementation and these changes are not related to changes in circulating hormone concentrations obtained in the resting, postabsorptive state. In addition, creatine supplementation appears to be effective for maintaining muscular performance during the initial phase of high-volume resistance training overreaching that otherwise results in small performance decrements.

**Potential ergogenic effects of arginine and creatine supplementation.**

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**Abstract** The rationale for the use of nutritional supplements to enhance exercise capacity is based on the assumption that they will confer an ergogenic effect above and beyond that afforded by regular food ingestion alone. The proposed or advertised ergogenic effect of many supplements is based on a presumptive metabolic pathway and may not necessarily translate to quantifiable changes in a variable as broadly defined as exercise performance. L-arginine is a conditionally essential amino acid that has received considerable attention due to potential effects on growth hormone secretion and nitric oxide production. In some clinical circumstances (e.g., burn injury, sepsis) in which the demand for arginine cannot be fully met by de novo synthesis and normal dietary intake, exogenous arginine has been shown to facilitate the maintenance of lean body mass and functional capacity. However, the evidence that supplemental arginine may also confer an ergogenic effect in normal healthy individuals is less compelling. In contrast to arginine, numerous studies have reported that supplementation with the arginine metabolite creatine facilitates an increase in anaerobic work capacity and muscle mass when accompanied by resistance training programs in both normal and patient populations. Whereas improvement in the rate of phosphocreatine resynthesis is largely responsible for improvements in acute work capacity, the direct effect of creatine supplementation on skeletal muscle protein synthesis is less clear. The purpose of this review is to summarize the role of arginine and its metabolite creatine in the context of a nutrition supplement for use in conjunction with an exercise stimulus in both healthy and patient populations.

**Short-term creatine supplementation does not improve muscle activation or sprint performance in humans.**

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**Abstract** The purpose of this study was to examine the influence of short-term creatine (Cr) supplementation on exercise-induced transverse relaxation time (T2) and sprint performance during maximum intermittent cycling exercise using the muscle functional magnetic resonance imaging (mfMRI) technique. Twelve men were divided into a Cr
supplementation group [the Cr group, taking 4 x (5 g Cr monohydrate + 2.5 g maltodextrin)/day], or a placebo supplementation group (the P group, taking 4 x 7.5 g maltodextrin/day). The allocation to the groups was based on cycling tests and the subject's physical characteristics, and thus was not randomized. A double-blind research design was employed for a 5-day supplementation period. mfMR images of the right thigh were collected at rest and immediately after two, five, and ten 6-s sprint bouts of maximum intermittent cycling exercise with a 30-s recovery interval between sets. Before and after supplementation, blood was taken to calculate lactate accumulation, and the muscle volume of the thigh was determined by MRI. Following supplementation, there was significant body mass gain in the Cr group (P<0.05), whereas the P group did not change. The exercise-induced T2, blood lactate levels and sprint performance were not affected by Cr supplementation in any sprint bouts. These results suggest that short-term Cr supplementation does not influence short duration repetitive sprint performance and muscle activation and/or metabolic state during sprint cycling evaluated by mfMRI of the skeletal muscle in humans.

**Pre-exercise oral creatine ingestion does not improve prolonged intermittent sprint exercise in humans.**

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**Abstract**  
**BACKGROUND:** This investigation determined whether pre-exercise oral Cr ingestion could enhance prolonged intermittent sprint exercise performance. **METHODS:** EXPERIMENTAL DESIGN: a randomised, double-blind crossover design was employed. SETTING: testing was performed at the Western Australian Institute of Sport and participants were monitored and treated by both scientific and medical personnel. PARTICIPANTS: eight active, but not well-trained males with a background in multiple-sprint based sports acted as subjects for this investigation. INTERVENTIONS: subjects ingested either 15 g Cr.H2O or placebo 120 min and 60 min prior to the start of an 80-min maximal sprint cycling task (10 sets of multiple 6-sec sprints with varying active recoveries). Subjects were retested 14 days later, being required to ingest the alternate supplement and repeat the exercise test. MEASURES: performance variables (work done and peak power) were obtained throughout the exercise challenge. Muscle biopsies (vastus lateralis) were raised to a peak of 2348+/-223 micromol x l(-1) prior to the commencement of exercise after Cr ingestion. There were no significant changes in any cycling performance parameters following Cr ingestion, although blood La- was significantly lower (pless than 0.05) than placebo at all time points during were taken preexercise as well as immediately and 3 min post-exercise in order to determine concentrations of ATP, PCr, Cr, La- and glycogen. Venous blood was drawn prior to and on four occasions during : the exercise test, and analysed for Cr, NH3+, La- and pH. RESULTS: Serum Cr concentrations exercise, and plasma NH3+ accumulation was also significantly reduced (pless than 0.05) in the Cr condition, but only in the second half of the 80-min exercise test. Muscle ATP and TCr levels as well as postexercise PCr replenishment were unaffected following Cr administration. CONCLUSIONS: The data suggest that although the pre-exercise ingestion of a large Cr dose was shown to have some impact on blood borne metabolites, it does not improve maximal prolonged intermittent sprint exercise performance, possibly due to an insufficient time allowed for
uptake of serum Cr by skeletal muscle to occur. Therefore, this form of loading does not provide an alternative method of Cr supplementation to the traditional five-day supplementation regimes established by previous research.