

ORAL CREATINE SUPPLEMENTATION IN SPORTS

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Food supplements containing creatine products appeared on the market in the early 1990s. Since then, the sale of creatine has risen exponentially all around the world. The main explanation for this is the real ergogenic effect of this natural compound. Indeed, it has been proven that oral creatine supplementation can improve physical performance under certain conditions. These theoretical and practical aspects, as well as safety issues, will be addressed in this article.

WHAT IS CREATINE?

Creatine is a small peptide made of three amino-acids: glycine, arginine and methionine. This compound is first synthesised in the kidneys and finally in the liver. This natural synthesis of creatine is about 1 g per day. A normal diet also supplies approximately 1 to 2 g of creatine per day. Altogether the intake and the biosynthesis more or less equals the rate of degradation (in creatinine) of this peptide, which is approximately 2 g per day. A creatine-rich

diet (containing a lot of meat and fish) tends to decrease creatine endogenous production and vice versa. The average 120 g of the body's creatine that is contained at approximately 95% in the skeletal muscle is deeply involved in the cellular energetic homeostasis. When distributed within the skeletal muscle, creatine is phosphorylated in phosphocreatine (PCr). This amount of PCr is a highly energetic storable to rephosphorylate ADP (Adenosine DiPhosphate) in ATP (Adenosine TriPhosphate). It is therefore easy to understand that creatine (via PCr) is an energy reservoir inside the skeletal muscle that can be rapidly used for single or repeated muscle contractions.

HOW DOES CREATINE IMPROVE PHYSICAL PERFORMANCE?

It is hard to believe but oral supplementation with creatine induces, in most subjects, a significant increase in intramuscular creatine (and then PCr) content. Various studies have shown that

regular intakes of creatine increase creatine and PCr intramuscular concentration by 10 to 40%. This is possible because creatine is not degraded during digestion and almost 99% of creatine oral intakes are either stored in the muscles or excreted in urine. The percentage amount of creatine taken up by the muscles varies among individuals and is also dependent upon the athlete's diet, particularly his/her meat and fish intake. As expected, vegetarian athletes show the highest muscle uptakes after an oral creatine supplementation.

As PCr and ATP represent limited but highly available energy stores for high-intensity short duration muscle activity, we can understand the purported ergogenic effects of an oral creatine supplementation¹.

This regime improves performance of repeated high-intensity exercise from 0.5 to 10% according to the mode of exercise and the athlete's profile. It increases strength and lean body mass and enhances fatigue resistance for exercises lasting less than 30 seconds. When combined,



Above: Wrestling athletes may benefit from an oral creatine supplementation.

creatine supplementation and progressive resistance training show some synergistic positive results². The mechanisms underlying creatine supplementation-induced improvements and body composition changes are metabolic (through increased pre-exercise PCr and muscle glycogen concentrations) as well as molecular (through increased gene expression of growth factors). Although creatine supplementation reduces muscle damage³, it does not increase skeletal muscle protein synthesis⁴.

WHICH SPORTS BENEFIT FROM CREATINE SUPPLEMENTATION?

As explained above, the sports where athletes might benefit from an oral creatine supplementation are mainly:

- high intensity, low duration physical activities e.g. sprinting (cycling or running), jumping, throwing,
- individual or team sports with aerobic and anaerobic lactic activities e.g. football, basketball, rugby, handball, squash, tennis, boxing, wrestling, judo, gymnastics,
- endurance sports e.g. cycling stage races.

Indeed, it has been shown that high muscle PCr stores boosted glycogen resynthesis.

HOW SHOULD I ORGANISE MY CREATINE SUPPLEMENTATION PLAN?

There are two ways to increase creatine content in muscle: the fast way and the slow way. The fast way is achieved through a 'loading' dose of 20 g per day for 5 days. These 20 g doses should be split in four daily

intakes of 5 g. The slow way is achieved in approximately 1 month through a single daily intake of 3 g.

So, the ergogenic effect will be maximal either after 5 days or after 30 days according to the strategy chosen. Whatever the chosen strategy, the benefit of this first course of creatine supplementation can be maintained (if needed) by a regular ingestion of approximately 3 g of supplementary creatine. Once the supplementation is stopped, intramuscular concentrations of PCr return to baseline level in approximately 2 to 3 weeks.

The type and duration of oral supplementation should be decided according to the training and competitive goals. For instance, an athlete taking part to a 2-day football tournament should choose a 5-day loading and then stop. A tennis player taking part in five tournaments in a month should choose a 5-day loading plan followed by a 3 g per day for 3 weeks maintaining plan. A judoka preparing an important 2-day tournament should rather opt for a 3 g daily

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intake scheme during the month before the event. The reason for that is a better control of the creatine supplementation-induced weight gain (see below). Indeed, in this particular case, a rapid weight gain close to the weigh-in could be problematic.

IS CREATINE SUPPLEMENTATION DANGEROUS TO HEALTH?

Other than some initial and isolated reports about possible renal and hepatic side-effects, no medically significant side-effects have been reported from creatine supplementation despite its widespread use⁵. It is, however, not recommended to advise creatine supplementation in athletes with pre-existing or potential renal dysfunctions.

Although 5 years of supplementation have not been shown to cause kidney or liver disturbances, it is not recommended to consume high doses (more than 20 g) of creatine over long periods (several weeks).

So far, the only documented side-effects of creatine supplementation are moderate and rapid weight gain and possible muscle cramping. The weight gain is not related to muscle anabolism but is secondary to water retention associated to creatine storage within the skeletal muscle. This water retention can reach up to 1 kg in less than a week.

Last but not least, I believe that creatine supplementation should not be proposed to minors or adolescents. In young athletes, optimisation of performance can be achieved by different and more effective pedagogical means.

IS CREATINE SUPPLEMENTATION DOPING?

Creatine is not on the World Anti Doping Agency list of banned substances or methods. It is not considered as a doping substance. However, consumers should be aware that some creatine-containing supplements might be contaminated by some xenobiotics either toxic or able to produce an adverse analytical finding during an anti-doping test. Producer's quality controls and purity of creatine supplements must be checked before consuming.

WHAT ABOUT NOVEL FORMS OF CREATINE?

Creatine monohydrate is the oldest and most common form sold on the market. More recently, novel forms of creatine have appeared: creatine salts, creatine ester, liquid creatine. However, the efficacy, safety and regulatory status of most of these new forms found in dietary supplements have not been well-established. So far there is little to no evidence supporting marketing claims that these newer forms of creatine are more stable, digested faster, more effective in increasing muscle creatine levels and/or associated with fewer side-effects than creatine monohydrate⁶. The only relevant improvement is regarding association-containing creatine monohydrate and carbohydrates. The latter have been proven to enhance creatine uptake by the muscle. Conversely, caffeine consumption during creatine supplementation inhibits its storage with the muscle.

KEY POINTS

- 1 Oral creatine supplementation is able to increase physical performance in athletes involved in sports with a significant anaerobic component. However, the obtained gain varies among individuals; some of them experiencing marginal gains.
- 2 Oral supplementation can be organised either on a short scheme: 5 g, 4 times a day for 5 days or a long scheme: 3 g per day for 30 days. Both lead to similar final ergogenic results.
- 3 When purity of the product exists, creatine supplement seems to be a safe nutritional manipulation. It should not be proposed to minors or athletes with existing or suspected kidney diseases.
- 4 Oral creatine supplementation, although performance-enhancing, is not considered as a doping practice, but there is a risk of contamination with banned substances.

References

1. Poortmans JR, Rawson ES, Burke LM, Stear SJ, Castell LM. A-Z of nutritional supplements: dietary supplements, sports nutrition foods and ergogenic aids for health and performance Part 11. *Br J Sports Med.* 2010; 44:765-766.
2. Branch JD. Effect of creatine supplementation on body composition and performance: a meta-analysis. *Int J Sport Nutr Exerc Metab* 2003; 13:198-226.
3. Rawson ES, Persky AM. Mechanisms of muscular adaptations to creatine supplementation. *Int SportMed J* 2007; 8:43-53.
4. Louis M, Poortmans JR, Francaux M, Berré J, Boisseau N, Brassine E et al. No effect of creatine supplementation on human myofibrillar and sarcoplasmic protein synthesis after resistance exercise. *Am J Physiol Endocrinol Metab* 2003; 285:E1089-1094.
5. Kim HJ, Kim CK, Carpentier A, Poortmans JR. Studies on the safety of creatine supplementation. *Amino Acids* 2011; 40:1409-1418.
6. Jäger R, Purpura M, Shao A, Inoue T, Kreider RB. Analysis of the efficacy, safety, and regulatory status of novel forms of creatine. *Amino Acids* 2011; 40:1369-1383.

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