

Creatine Supplements: For More Than Just Sports



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Creatine is one of the most popular ergogenic supplements on the market.[1] It was widely introduced in the early 1990s after athletes competing in sprint and power events at the Barcelona Olympic Games suggested that it enhanced their performance.[2] Since that time, its benefits have been studied in many other sports as well as in conditions as diverse as neurological disorders, depression, memory loss, and the chronic diseases and muscle loss common with aging. Over the years, questions have been raised about its potential side effects. However, currently creatine supplementation is considered safe for healthy adults.[1,3]

Creatine is an amino acid naturally found in the body; about 95% of creatine is stored in muscle with the remaining amount found in other tissues including the brain. About two thirds of the creatine in the body is converted to phosphocreatine (PCr). PCr can be used to regenerate ATP, which provides energy to fuel cellular processes. Having more creatine increases the amount of PCr, which enhances the availability of ATP.[4]

The body requires approximately 2 g of creatine to replenish what is used daily. About half of this amount is produced in the body, primarily in the liver and kidneys.[1,4] The rest is obtained from animal products in the diet, mainly meat, poultry, and fish. The average creatine intake in

the US is estimated to be 1.38 g/day, however almost 43% of individuals surveyed consumed less than 1 g/day.[5] Vegetarians, for example, consume almost no creatine and have lower muscle levels than meat eaters.

Use and Safety of Creatine Supplements

Creatine supplements have a global market of over \$500 million.[5] Supplements are available over the counter in several forms, the most common and most studied of which is creatine monohydrate. Creatine, when sold as a dietary supplement, is not regulated by the US Food and Drug Administration (FDA) and therefore may contain contaminants and may not provide the exact amount of creatine listed on the label. The creatine monohydrate used to fortify foods such as energy drinks and protein bars is considered a food additive. The FDA, which does regulate ingredients added to food, has categorized this use of creatine as “generally recognized as safe” (GRAS), supporting the view that it is safe for consumption.[6]

Nonetheless, misconceptions still exist about the safety and side effects of creatine, particularly with regard to kidney function, weight gain, and muscle cramping. Perhaps the greatest concern about creatine supplementation is that it could harm the kidneys. Both creatine and PCr are degraded to creatinine, which is excreted by the kidneys. There has been speculation that increasing the load of creatine and creatinine that needs to be excreted by the kidneys could result in renal damage. Blood creatinine levels do increase when kidney function is poor. However, blood creatinine levels are also dependent on muscle mass and the amount of dietary creatine consumed, so transient high serum creatinine may reflect the increased creatine intake rather than failing kidneys. A meta-analysis of creatine supplements and renal function found that supplementation did not cause renal damage.[7] This and many other studies provide evidence that 3 to 5 grams/day of supplemental creatine does not negatively affect renal function.[3,4]

The concern that creatine supplementation leads to unhealthy weight gain or muscle cramps is also unfounded. Creatine supplementation may cause weight gain but does not increase fat mass. Some weight gain occurs due to an increase in muscle. This is because over time creatine supplementation allows for greater training intensity, resulting in an increase in muscle mass.[4] There also may be a transitory increase in body weight from fluid retention over the first few days of supplementation.[3] Shifts in fluid distribution due to creatine supplementation have also been speculated to cause dehydration and muscle cramping in hot environments. However, a study that compared creatine use to a placebo found that creatine users had a lower incidence of muscle cramps and dehydration than the control group.[3]



Ergogenic Benefits of Creatine Supplements?

Increasing creatine consumption increases muscle creatine and PCr levels. More PCr means a larger supply of ATP, the primary energy source for short intense bouts of exercise. The increased availability of ATP delays fatigue, enhancing training, and leading to stronger muscles and ultimately improved exercise performance. Creatine has been shown to improve muscle mass and performance in athletes engaged in most sports as well as to help with post-exercise recovery and injury prevention. While it can increase muscle mass, it is not an anabolic steroid or a controlled substance; it is not screened for, or banned by, the World Anti-Doping Agency (WADA) or any other sports agency.[3]

The most effective way to increase muscle creatine stores is to consume 3–5 g/day of supplemental creatine monohydrate.[1] A loading dose of 5 grams four times a day for 5 to 7 days can be used to rapidly increase muscle stores of creatine.[4] However, the loading phase is not necessary to get the benefits of creatine – it just takes longer for muscle creatine levels to rise without loading.

Creatine is a popular supplement among adolescent athletes and theoretically the ergogenic benefit should be similar to that seen in adults.[3] But, the lack of randomized controlled trials and acute and long-term safety data has limited widespread support for creatine use in children and adolescents.[8]

Creatine and the Brain

The brain requires a constant supply of ATP. As in muscle, brain PCr is important for resynthesizing ATP from ADP. Creatine supplementation appears to increase brain creatine content; however, studies have used a wide range of creatine doses, so the amount needed to

raise brain levels is not as well established as that for increasing muscle creatine.[9] An increase in brain creatine is thought to be beneficial in conditions that affect mood, cognition, and motor tasks. Creatine supplementation has therefore been suggested as a treatment for a variety of neurological and mental health conditions and to have a neuroprotective effect following traumatic brain injury and concussions. Supplementation has been found to have limited, if any, benefits for the treatment of multiple sclerosis, Parkinson's, and Huntington's disease.[9] Research does suggest a possible role for creatine supplementation in the treatment of depression, anxiety, and post-traumatic stress disorder (PTSD). For example, there is a link between low dietary intake of creatine and the risk of depression in adults. A number of case studies and small clinical trials of creatine supplementation alone as well as with traditional pharmacological interventions have observed improvements in the symptoms of depression, but additional larger-scale randomized trials are needed. Individuals with generalized anxiety and PTSD have been found to have reduced levels of brain creatine; small studies have shown improvement with creatine supplementation. Based on limited evidence creatine supplementation for the management of concussion and traumatic brain injury appears promising.[9]

Creatine supplementation has also been studied for its effect on memory, which is an energy demanding function. Studies have gotten mixed results, with some showing creatine to benefit cognitive function and memory and others showing no effect. A meta-analysis found that creatine supplements have a beneficial effect on memory in healthy individuals and the benefits were greater in older adults.[10]

Potential Benefits of Creatine in Aging

Creatine supplementation has been studied for its effect on a number of health concerns that increase with age, such as osteoporosis, heart disease, and insulin resistance.[1,11] While there is some evidence supporting a benefit in these conditions, more research is needed. Creatine can help older adults prevent sarcopenia, the loss of muscle mass and strength that occurs with aging. Although creatine supplements alone do not benefit muscle function or mass, when taken in conjunction with resistance exercise, creatine supplements have been found to enhance gains in muscle mass and strength in older adults. Maintaining muscle lessens the risk of falls, fractures, and physical disability, which reduce independence in older adults.[12,13]

Potential Benefits for Vegetarians

Vegetarians consume almost no creatine. And although creatine synthesis is augmented in vegetarians, they still have lower blood and muscle levels.[14] Creatine supplementation has been shown to increase lean tissue mass as well as muscle strength and endurance in

vegetarians.[15] However, it is unclear whether creatine supplements improve exercise performance to a greater extent in vegetarians than in non-vegetarians. Despite their low creatine intake, brain creatine concentrations in vegetarians appears to be similar to that in omnivores. Nonetheless, creatine supplementation was found to improve memory in vegetarians but not in omnivores.[15] The lower creatine stores in vegetarians, and improvements in muscle strength and memory with supplementation, has led to the suggestion that supplemental creatine may be necessary to optimize health in vegetarians.[1,14] Although risks are low, more study is needed before a general recommendation can be made.

Summary

When taken at doses in the range 3-5 g/day, creatine supplements are safe and can be beneficial for healthy adults.[3] Over 1000 short and long-term studies of creatine supplements at various doses in healthy and diseased populations in different life-stage groups have consistently shown that creatine poses no adverse health risks.[4] The International Society of Sports Nutrition, the Academy of Nutrition and Dietetics, and the American College of Sports Medicine all concur that creatine is the most effective ergogenic nutritional supplement currently available for increasing high-intensity exercise capacity and lean body mass in response to training.[4] Supplemental creatine, when combined with resistance exercise, helps maintain muscle mass in older adults.[12] Many clinical applications of supplemental creatine have been studied. A potential benefit has been demonstrated for improving depression and memory,[9,10] but the benefits in other conditions are not well established.[1,3] Vegetarians, whose diets contain almost no dietary creatine and have low creatine levels, may benefit from supplementation.[15]

Editor's comment: Further studies are needed to determine if it is safe or even beneficial for patients with renal insufficiency to take supplemental creatine. [16]

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