Creatine Loading: Facts and Opinions

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Initial laboratory research regarding creatine supplementation suggested a natural substance that would improve an athlete's ability to train, especially for short bursts of work. Only one year ago, creatine continued to be regarded as a relatively cheap supplement with few negative effects.

With continued research, does the outlook still look so rosy? What happens when the tests move from the laboratory to the track or the pool? Can the weight gained through creatine use counter the positive attributes noted in the initial tests? And what about the ethical side of the question? Does supplementation with a substance found in minute quantities in the food supply undermine the essence of sport participation? It has been estimated that an athlete would need to consume 4.5 kg (10 lb.) of meat and fish per day to match the creatine intake supplied in the 20 g dose frequently used for creatine loading. Since cooking destroys most of the natural creatine, an additional health concern enters the discussion: how to attain the desired intake in a "natural" manner. Let's examine what we know about creatine supplementation and loading.

What is creatine?

Creatine (Cr) is made in the liver, kidney and pancreas from amino acids arginine, glycine, and methionine. Humans require about 2 g per day. It is estimated that humans produce about 1 g creatine per day and obtain 1 g from food. Creatine is found in raw meat and fish (about 5 R Cr per kg raw flesh), but much of the creatine is destroyed in cooking. An abnormally high intake of creatine can be attained by ingesting commercially available creatine supplements such as creatine monohydrate.

How does Creatine work in the body?

Most of the creatine in the body is in skeletal muscle. Creatine exists as free creatine or as phosphocreatine (PCr) (that is, combined with phosphate by a high energy bond). Phosphocreatine acts as an energy storage unit.
During muscular contraction, energy is released from adenosine triphosphate (ATP) and a high-energy phosphate bond is 'broken' to form adenosine diphosphate (ADP) and free phosphate (P).

ATP Þ ADP + P + energy

In the presence of oxygen (aerobic activity), ATP is generated from the breakdown of carbohydrate and/or fat. In the absence of adequate oxygen, phosphocreatine is used to regenerate ADP to ATP, restoring energy for muscular contraction.

PCr + ADP Þ ATP + Cr

Thus, phosphocreatine is most important during high-intensity, short-term anaerobic exercise, or when all-out efforts must be repeated. Even with optimal levels of muscle creatine, phosphocreatine can provide only limited energy regeneration. During all-out efforts, phosphocreatine stores can provide energy for six to 10 seconds. Theoretically, if a person does not have peak creatine and phosphocreatine levels, the ability to restore ATP during high-intensity activity could be reduced In theory, phosphocreatine supplementation could be beneficial for athletes who must repeat all-out exercise bouts over time. At this time, research outside laboratory situations has not clearly substantiated the theory.

Will taking a creatine supplement improve performance?

Research results are NOT consistent regarding improved performance as a result of creatine supplementation. A number of factors may explain these discrepancies. The following is a summary of recent research.

Following supplementation, usually with creatine monohydrate, performance may improve during the later repetitions when brief, high-intensity activities are performed repeatedly (for example, six-second sprints on a bicycle ergometer).
Most studies show little or no improvement in performance of a single effort, and no increase in the maximum speed that can be reached by an athlete during a sprint.
The response to creatine supplementation varies from one person to another. In controlled laboratory tests, when initial muscle creatine levels were low, there was greater improvement. There was little or no improvement if muscle creatine levels were high or near normal.

Creatine supplementation is associated with weight gain (see side-effects). Where an increase in body weight has a detrimental effect on performance, supplementation may impede rather than improve performance. Where body weight is supported (bicycle or rowing ergometer), increased body weight may have less impact.

Endurance does NOT benefit from creatine increase because a different energy system is used. In addition, the weight gain from creatine supplementation is likely to be an impediment during endurance activities.

Questions are now being posed in the research literature regarding the training status of the experimental subjects. For instance, are the improvements greater in untrained subjects than in highly trained individuals? Do highly trained athletes obtain any benefit from the supplementation?

Research has shown that vegetarians tend to have lower levels of muscle creatine. This requires further study with larger numbers of subjects. The observation of lower levels of creatine among vegetarians suggests a limited capacity for endogenous creatine production. Dietary sources of creatine from meat and fish may be important food selection considerations for peak muscle creatine levels.

Are there side-effects?

The side-effect most frequently reported in the experimental literature is weight gain of up to three kilograms. The weight gain occurs very quickly, in the first day or two of creatine supplementation. This rapid weight gain suggests the weight is a result of fluid retention rather than lean muscle tissue.

In one survey, 14 of 17 participants reported "tightness in muscles" for several days following the loading phase.

The endogenous production of creatine stops when creatine supplements are consumed, but appears to resume after supplementation ends. There are anecdotal reports of athletes experiencing diarrhea and stomach cramping. Others report skin irritation such as itching. Muscle cramping has also been reported.

Are there long-term consequences?

There are no long-term studies at this time. All research has been conducted on adults and safety for youth is unknown. Most research has been conducted using low doses for a short period of time (20 to 30 g Cr for five days followed by 2 g per day). The long-term consequences of large doses over extended time periods have not been documented.

Is there a simple test to determine whether muscle creatine level is below average?

No. Experimental studies use a muscle biopsy to determine the actual muscle creatine content. A hollow needle is inserted into the muscle to withdraw a sample of muscle tissue for analysis. Since individuals with adequate muscle stores do not retain additional creatine from supplementation, some studies have used weight gain as an indicator of low initial creatine status. This assumes that any weight gain is the result of creatine retention within the muscle and that the creatine retention leads to fluid retention to increase body weight. By this reasoning, if the athlete has adequate creatine levels, there would be no weight gain since there is an upper limit for muscle creatine.

Advocates of supplementation (or perhaps those who gain financially from the sale of creatine) suggest athletes consume 20 g per day for five days to check whether performance improves. If this is done, performance must be tested in a very objective manner with time trials, number of repetitions one can complete with a standard weight, and so on. Since such tests often do not include a control group to measure improvement without the supplementation, and since 20 per cent of the population will

improve based on the belief that the supplement will help (placebo effect), this is NOT a good indicator of initial creatine levels.

Does an increase in muscle creatine result in an increase in muscle phosphocreatine?

Few studies have analysed the phosphocreatine levels in muscle. A recent study has shown no increase in muscle phosphocreatine and no effect on a single short-term maximal cycling task in spite of increased muscle creatine. Further study is necessary to understand the effect of creatine supplementation on muscle phosphocreatine level and on performance.

Before athletes buy, they should compare the cost, consider potential risks/unknowns, examine the research results, analyse their eating pattern and training schedule, and weigh the choices.

Is creatine banned?

NO.

Is using creatine the first step toward a "doping outlook"?

Some suggest that reaching for any chemical interferes with the Spirit of Sport and the joy of competition for the intrinsic value of sport. An athlete may start by looking for a chemical edge and proceed to reaching for a banned substance. Studies indicate an attitude toward doping begins with a relatively innocuous substance that the athlete hopes will provide a shortcut to success. Consequently, coaches should be extremely concerned about the ethical implications of condoning or encouraging creatine supplementation.