FREE

Creatine's Usage in Sports, Health and Anti Aging

The Creatine Report

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Want to lose fat?

Want to gain muscle?

Contents

Introduction

Although creatine offers an array of benefits, most people think of it simply as a supplement that bodybuilders and other athletes use to gain strength and muscle mass. Nothing could be further from the truth.

People who don't follow the research on creatine are often stunned to find out how much research has been done, and how many uses creatine may have for health, fitness, and longevity.

Why the mainstream media has ignored this fact – in favor of outlandish and poorly substantiated scare stories – is unclear, but there has always been a double standard in the mainstream media when it comes to nutritional supplements.

This report will cover much of what creatine has to offer as a safe and inexpensive supplement with an exceptionally wide range of potential uses. Though I will go into depth about each, creatine may :

- improve sarcopenia (a loss of muscle mass due to aging)
- improve brain function of healthy and damaged brains
- modulate inflammation.
- treat diseases effecting the neuro muscular system, such as muscular dystrophy
- mitigate wasting syndromes/muscle atrophy
- reduce fatigue
- treat gyrate atrophy
- improve the symptoms of Parkinson's disease
- improve Huntington's disease and other mitochondrial cytopathies
- increase growth hormone (GH) levels, to those seen with exercise
- reduce homocysteine levels
- possibly improve the symptoms of Chronic Fatigue Syndrome
- improve cardiac function in those with congestive heart failure

Creatine is proving to be one of the most promising, well researched, and safe supplements ever discovered for an exceptionally wide range of uses.

Part I

What is creatine?

Creatine is formed in the human body from the amino acids methionine, glycine and arginine. The average person's body contains approximately 120 grams of creatine stored as creatine phosphate. Certain foods such as beef, herring and salmon, are fairly high in creatine. However, a person would have to eat pounds of these foods daily to equal what can be obtained in one teaspoon of powdered creatine.

Creatine is directly related to adenosine triphosphate (ATP). ATP is formed in the powerhouses of the cell, the mitochondria. ATP is often referred to as the "universal energy molecule" used by every cell in our bodies. An increase in oxidative stress coupled with a cell's inability to produce essential energy molecules such as ATP, is a hallmark of the aging cell and is found in many disease states. Key factors in maintaining health are the ability to: (a) prevent mitochondrial damage to DNA caused by reactive oxygen species (ROS) and (b) prevent the decline in ATP synthesis, which reduces whole body ATP levels. It would appear that maintaining antioxidant status (in particular intra-cellular glutathione) and ATP levels are essential in fighting the aging process.

It is interesting to note that many of the most promising anti-aging nutrients such as CoQ10, NAD, acetyl-l-carnitine and lipoic acid are all taken to maintain the ability of the mitochondria to produce high energy compounds such as ATP and reduce oxidative stress. The ability of a cell to do work is directly related to its ATP status and the health of the mitochondria. Heart tissue, neurons in the brain and other highly active tissues are very sensitive to this system. Even small changes in ATP can have profound effects on the tissues' ability to function properly. Of all the nutritional supplements available to us currently, creatine appears to be the most effective for maintaining or raising ATP levels.

How does creatine work?

In a nutshell, creatine works to help generate energy. When ATP loses a phosphate molecule and becomes adenosine diphosphate (ADP), it must be converted back to ATP to produce energy. Creatine is stored in the human body as creatine phosphate (CP) also called phosphocreatine. When ATP is depleted, it can be recharged by CP. That is, CP donates a phosphate molecule to the ADP, making it ATP again.

An increased pool of CP means faster and greater recharging of ATP, which means more

work can be performed. This is why creatine has been so successful for athletes. For short-duration explosive sports, such as sprinting, weight lifting and other anaerobic endeavors, ATP is the energy system used.

To date, research has shown that ingesting creatine can increase the total body pool of CP which leads to greater generation of energy for anaerobic forms of exercise, such as weight training and sprinting. Other effects of creatine may be increases in protein synthesis and increased cell hydration.

Creatine has had spotty results in affecting performance in endurance sports such as swimming, rowing and long distance running, with some studies showing no positive effects on performance in endurance athletes. Whether or not the failure of creatine to improve performance in endurance athletes was due to the nature of the sport or the design of the studies is still being debated.

Creatine can be found in the form of creatine monohydrate, creatine citrate, creatine phosphate, creatine-magnesium chelate and even liquid versions.

However, the vast majority of research to date showing creatine to have positive effects on pathologies, muscle mass and performance used the monohydrate form. Creatine monohydrate is over 90% absorbable, contrary to what some companies and "gurus" have claimed.

What follows is a review of some of the more interesting and promising research studies with creatine.

Part II

Creatine and sarcopenia

Creatine has been shown to increase strength and muscle mass in young adults in literally dozens of studies at this point. However, there was scant data examining its effects on older adults until more recently.

One of the greatest threats to an aging adult's ability to stay healthy and functional is the steady loss of lean bodymass (muscle and bone in particular) as they age. The medical term for the loss of muscle is sarcopenia, and it's starting to get the recognition it deserves by the medical and scientific community.

For decades, that community has focused on the loss of bone mass (osteoporosis) of aging adults but paid little attention to the loss of muscle mass which effects a person's ability to be functional as they age just as much – if not more so – then a loss of bone mass. What defines sarcopenia from a clinical perspective? Sarcopenia can be defined as the age-related loss of muscle mass, strength and functionality. One thing is very clear: it's far easier, cheaper, and more effective to prevent sarcopenia, or at least greatly slow its progression, then it is to treat it later in life. Sarcopenia generally appears after age of 40 and accelerates after the age of approximately 75.

Although sarcopenia is mostly seen in physically inactive individuals, it is also commonly found in individuals who remain physically active throughout their lives. Thus, it's clear that although physical activity is essential, physical inactivity is not the only contributing factor to sarcopenia. Just as with osteoporosis, sarcopenia is a multifactorial process that may include decreased hormone levels (in particular, GH, IGF-1, and testosterone), a lack of adequate protein and calories in the diet, oxidative stress, inflammatory processes, as well as a loss of motor nerve cells.

Creatine and older adults

With aging and inactivity, most atrophy an aging person's muscle mass is seen in the fast twitch (FT) fibers which are recruited during high-intensity, anaerobic movements (e.g., weight lifting, sprinting, etc.). Interestingly, these are exactly the fibers creatine has the most profound effects on. One study called "Creatine supplementation enhances isometric strength and body composition improvements following strength exercise training in older adults" (*J Gerontol A Biol Sci Med Sci.* 2003 Jan;58(1):11-9.) fed twenty-eight healthy men and women (above 65 years old) either 5 grams per day of creatine

or placebo using a random, double-blind protocol for 14 weeks.

Both groups were put on a resistance training (weight training) regimen for the duration of the study. Fourteen weeks of resistance exercise training resulted in significant increases in all measurements of strength and functional tasks and muscle fiber area for both groups. However, the group getting the creatine resulted in significantly greater increases in fat-free mass, greater increase in isometric knee extension, greater gains in isometric dorsiflexion strength, as well as a significant increase in intramuscular creatine levels. The researchers concluded:

"The addition of creatine supplementation to the exercise stimulus enhanced the increase in total and fat-free mass, and gains in several indices of isometric muscle strength."

A whole slew of recent studies have been finding similar effects on older adults and coming to virtually identical conclusions. Another recent study entitled "Creatine supplementation improves muscular performance in older men" (*Med Sci Sports Exerc.* 2002 Mar;34(3):537-43.) using a similar protocol as the aforementioned study found essentially the same effects.

They concluded:

"...data indicates that 7 days of creatine supplementation is effective at increasing several indices of muscle performance, including functional tests in older men without adverse side effects. Creatine supplementation may be a useful therapeutic strategy for older adults to attenuate loss in muscle strength and performance of functional living tasks."

Additional studies (Creatine supplementation combined with resistance training in older men. *Med Sci Sports Exerc.* 2001 Dec;33(12):2111-7.) have come to similar conclusions. However, it should be noted that not all studies have found this effect (Effects of creatine monohydrate ingestion in sedentary and weight-trained older adults. *Acta Physiol Scand.* 1998 Oct;164(2):147-55.) but they were earlier studies that may have had some methodological flaws. Regardless, the bulk of the data, in particular the recent data, clearly points to creatine as having positive effects on strength and body composition in older adults, especially when combined with a resistance training exercise protocol.

One particularly interesting recent study found the positive effects of creatine on strength and lean tissue in older adults continued after they stopped using the creatine (Effect of Ceasing Creatine Supplementation While Maintaining Resistance Training in

Older Men. *JAPA*, 12(3), July 2004.), at least for the 12 weeks they tested them. They concluded,

"Withdrawal from Creatine had no effect on the rate of strength, endurance, and loss of lean tissue mass with 12 weeks of reduced-volume training."

However, it's the experience of most creatine users, as well as most studies in younger adults, that the positive effects of creatine do in fact fade over time if one stops using creatine. Since there is no particular reason to go off creatine once started, the best effects will probably come from continued use.

The real secret to aging: cellular energetics

What's really the major difference between an older adult and a younger adult? Cellular energetics is the answer: the ability of each cell in our body to regulate is ability to produce energy (e.g., ATP), detoxify harmful compounds, and defend itself against free radical damage and other assaults.

An increase in oxidative stress coupled with a cell's inability to produce essential energy molecules such as ATP, is a hallmark of the aging cell and is found in many disease states. A younger persons' cells are quite efficient at dealing with those problems faced by the cell, an older person's cells, be it brain cells, muscle cells, etc. are unable to deal with these challenges, and over time damage accumulates, and the cell dies. In younger healthy adults, old cells are replaced by new healthy cells rapidly, but that's not the case the older we get.

The decline in muscle mass (sarcopenia) with aging may be related to a decline in mitochondrial function. Without these high energy compounds, which every cell in our body depends to function, the cell and the entire organism (us!) dies.

It's been established that older adults tend to have lower tissue levels of creatine phosphate (CP), ATP, and other essential high energy molecules.

Older individuals appear to respond differently to exercise also in terms of replenishing these essential molecules after exercise. One study called "Skeletal muscle mitochondrial function and lean body mass in healthy exercising elderly" (*Mech Ageing Dev.* 2003 Mar;124(3):301-9.) measured mitochondrial function andrecovery time in 45 older (average age 73), and 20 younger subjects (average age 25) who were matched for body mass. They then had the two groups exercise at different intensity levels. As other studies have found, older people in the group had lower baseline CP and ATP levels

then their younger counterparts and they were slower to replenish tissue levels after exercise. As the researchers put it:

"Our data suggests that mitochondrial function declines with age in healthy, exercising elderly adults and that the decline appears to be influenced by the level of physical activity."

Translated, not only did the older subjects have lower levels of essential high energy compounds (e.g. ATP, CP, etc.) to begin with compared to the younger group, it was made worse the more intense the exercise! As the studies above with older adults show, creatine in supplemented form can ameliorate some of that decline.

Creatine may be one of the most effective and safe non-prescription compounds currently available to improve cellular energetics (the ability of the cells to produce energy which keeps us alive!) and may be an effective treatment for sarcopenia, especially when combined with the proper exercise regimen.

To sum up this section, the two essential strategies to help prevent the decline in cellular health, which appears linked to sarcopenia and other issues faced by an aging person are:

1. prevent concomitant decline in ATP/CP levels - which reduces whole body ATP levels and leads to sarcopenia and many other pathologies - via the use of creatine and other supplements that maintain cellular energetics (e.g., acetyl-l-carnitine, alpha lipoic acid, QoQ10, etc.)

2. Increase or maintain intracellular glutathione and improve mitochondrial anti oxidant status (to prevent mitochondrial damage to DNA caused by reactive oxygen species) by taking anti oxidants and or nutrients known to improve anti oxidant status (e.g. whey protein, NAC, etc).

It would appear that maintaining mitochondrial antioxidant status (in particular intra cellular glutathione) and ATP levels, is an essential combination in fighting the aging process as well as combating/preventing a host of diseases.

Anti-inflammatory effects of creatine

Interestingly, though not surprisingly, creatine may have the ability to modulate inflammation, at least after exercise. One study entitled "The effect of creatine supplementation upon inflammatory and muscle soreness markers after a 30km race"

(*Life Sci.* 2004 Sep 3;75(16):1917-24.) examined this issue.

The researchers looked at the effect of creatine on inflammatory and muscle soreness markers: creatine kinase (CK), lactate dehydrogenase (LDH), prostaglandin E2 (PGE2) and tumor necrosis factor-alpha (TNF-alpha) in experienced runners after running 30km.

Runners were supplemented for 5 days prior to the 30km race with 4 doses of 5g of creatine and 15g of maltodextrine per day while the control group received the same amount of maltodextrin. Pre-race blood samples were collected before running the 30km, immediately after the race, and 24 hours after the end of the run.

As one would expect, the control group had large increases in CK, LDH, PGE2, and TNF-alpha concentrations. In fact, there was over a four fold increase in CK, 43% increase in LDH, over a 6 fold increase in PGE2, and a doubling of TNF-alpha! This indicates a high level of cell injury and inflammation in these athletes. However, the group getting the creatine had far lower indicators of cellular damage and inflammation, with a 19% increase in CK, 70% increase in PGE2, and a 34% increase in TNF-alpha. Creatine supplementation totally abolished the increase in LDH. No side effects at all were reported by the athletes getting the creatine. The researchers concluded:

"These results indicate that creatine supplementation reduced cell damage and inflammation after an exhaustive intense race."

There are a few comments and questions to be made regarding these findings. Regular exercise is an essential component for any person looking to improve their health, keep bodyfat low, retain essential muscle mass as they age, etc., but it also has it's downsides, such as increased free radical production and other effects the body has to combat.

Creatine may be a key nutrient here. However, it's unclear if it works in more moderate physical endeavors (as not everyone is running 30 km races all the time!) and whether it would have the same effects on inflammatory markers in non-exercising people. None the less, the results are compelling and add to the long list the potential benefits of creatine.

Creatine effects on the function of healthy and damaged brains.

Perhaps the most compelling use for creatine is its effects on brain function and metabolism. I covered some of those effects in the past two articles but research continues to show creatine is a key nutrient for brain function and metabolism in both people with healthy or damaged/diseased brains. Traumatic brain injuries

affect thousands of people each year. The real tragedy however is that much of the damage to the brain is not caused by the immediate injury, but due to cell death caused by ischemia (a lack of blood flow and oxygen to tissues) and free radical damage/oxidative stress. The ability of a cell to do work is directly related to its ATP status and the health of the mitochondria. Heart tissue, neurons in the brain and other highly active tissues are very sensitive to this system. Even small changes in ATP can have profound effects on the tissues' ability to function properly, which can cause damage and or death for the cell. Of all the nutritional supplements available to us currently, creatine appears to be the most effective for maintaining or raising ATP levels. Recent studies have shown that creatine affords significant neuroprotection against ischemic and oxidative insults. One recent study called "Dietary supplement creatine protects against traumatic brain injury" (*Ann Neurol.* 2000 Nov;48(5):723-9.) found creatine was very effective at reducing damage to brain tissue after injury. These researchers found:

"…administration of creatine ameliorated the extent of cortical damage by as much as 36% in mice and 50% in rats. Protection seems to be related to creatine-induced maintenance of mitochondrial bioenergetics."

They went on to conclude:

"This food supplement may provide clues to the mechanisms responsible for neuronal loss after traumatic brain injury and may find use as a neuroprotective agent against acute and delayed neurodegenerative processes."

This study would indicate creatine therapy should be initiated as soon as possible after traumatic brain injury. People who have already been taking creatine on a continuous basis may be afforded considerable protection against additional damage to the brain following such an injury.

Creatine and the healthy brain

But what about the healthy brain you ask? No, you don't need to injure your brain in an auto accident to get benefits! A recent study entitled "Oral creatine monohydrate supplementation improves brain performance: a double-blind, placebo controlled, cross-over trial" (*Proceedings of the Royal Society: Biological Sciences* ˆ Vol. 270, No. 1529 on 22 October 2003.) found that six weeks of creatine supplementation at 5g per day to 45 five vegetarians using a double blind placebo cross over designed study, greatly improved cognitive function. According the report put out by The Royal Society,"

"...results agree with previous observations showing that brain creatine levels correlate

with improved recognition memory and reduce mental fatigue."

Though creatine supplementation would probably have a less dramatic effect on non-vegetarians –due to the fact they get some creatine in their diet from the meat they eat – it stands to reason creatine will still be effective for improving creatine levels in the brain of meat eaters and vegetarians alike. Healthy and injured brains alike appear to benefit from creatine!

Creatine and neuromuscular diseases

One of the most promising areas of research with creatine is its effect on neuromuscular diseases such as Muscular Dystrophy (MD). One study looked at the safety and efficacy of creatine monohydrate in various types of muscular dystrophies using a double blind, crossover trial. Thirty-six patients (12 patients with facioscapulohumeral dystrophy, 10 patients with Becker dystrophy, eight patients with Duchenne dystrophy and six patients with sarcoglycan-deficient limb girdle muscular dystrophy) were randomized to receive creatine or placebo for eight weeks. The researchers found there was a "mild but significant improvement" in muscle strength in all groups. The study also found a general improvement in the patients' daily-life activities as demonstrated by improved scores in the Medical Research Council scales and the Neuromuscular Symptom scale. Creatine was well tolerated throughout the study period, according to the researchers.[1]

Another group of researchers fed creatine monohydrate to people with neuromuscular disease at 10 grams per day for five days, then reduced the dose to 5 grams per day for five days. The first study used 81 people and was followed by a single-blinded study of 21 people. In both studies, body weight, handgrip, dorsiflexion and knee extensor strength were measured before and after treatment. The researchers found,:

"Creatine administration increased all measured indices in both studies."

Short-term creatine monohydrate increased high-intensity strength significantly in patients with neuromuscular disease.[2] There have also been many clinical observations by physicians that creatine improves the strength, functionality and symptomology of people with various diseases of the neuromuscular system.

More brain related research: creatine and neurological protection

If there is one place creatine really shines, it's in protecting the brain from various forms of neurological injury and stress. A growing number of studies have found that creatine can protect the brain from neurotoxic agents, certain forms of injury and other

insults. Several in vitro studies found that neurons exposed to either glutamate or beta-amyloid (both highly toxic to neurons and involved in various neurological diseases) were protected when exposed to creatine.[3] The researchers hypothesized that:

"… cells supplemented with the precursor creatine make more phosphocreatine (PCr) and create larger energy reserves with consequent neuroprotection against stressors."

More recent studies, in vitro and in vivo in animals, have found creatine to be highly neuroprotective against other neurotoxic agents such as N-methyl-D-aspartate (NMDA) and malonate.[4] Another study found that feeding rats creatine helped protect them against tetrahydropyridine (MPTP), which produces parkinsonism in animals through impaired energy production. The results were impressive enough for these researchers to conclude:

"These results further implicate metabolic dysfunction in MPTP neurotoxicity and suggest a novel therapeutic approach, which may have applicability in Parkinson's disease."[5]

Other studies have found creatine protected neurons from ischemic (low oxygen) damage as is often seen after strokes or injuries.[6]

Yet more studies have found creatine may play a therapeutic and or protective role in Huntington's disease[7, 8] as well as ALS (amyotrophic lateral sclerosis).[9] This study found that:

"… oral administration of creatine produced a dose-dependent improvement in motor performance and extended survival in G93A transgenic mice, and it protected mice from loss of both motor neurons and substantia nigra neurons at 120 days of age. Creatine administration protected G93A transgenic mice from increases in biochemical indices of oxidative damage. Therefore, creatine administration may be a new therapeutic strategy for ALS."

Amazingly, this is only the tip of the iceberg showing creatine may have therapeutic uses for a wide range of neurological disease as well as injuries to the brain.

Creatine and heart function

Because it is known that heart cells are dependent on adequate levels of ATP to function properly, and that cardiac creatine levels are depressed in chronic heart failure, researchers have looked at supplemental creatine to improve heart function and overall

symptomology in certain forms of heart disease. It is well known that people suffering from chronic heart failure have limited endurance, strength and tire easily, which greatly limits their ability to function in everyday life. Using a double blind, placebo-controlled design, 17 patients aged 43 to 70 years with an ejection fraction <40 were supplemented with 20 grams of creatine daily for 10 days. Before and after creatine supplementation, the researchers looked at:

1. Ejection fraction of the heart (blood present in the ventricle at the end of diastole and expelled during the contraction of the heart)
2. 1-legged knee extensor (which tests strength)
3. Exercise performance on the cycle ergometer (which tests endurance)

Biopsies were also taken from muscle to determine if there was an increase in energy-producing compounds (i.e., creatine and creatine phosphate). Interestingly, but not surprisingly, the ejection fraction at rest and during the exercise phase did not increase. However, the biopsies revealed a considerable increase in tissue levels of creatine and creatine phosphate in the patients getting the supplemental creatine. More importantly, patients getting the creatine had increases in strength and peak torque (21%, $P < 0.05$) and endurance (10%, $P < 0.05$). Both peak torque and 1-legged performance increased linearly with increased skeletal muscle phosphocreatine ($P < 0.05$). After just one week of creatine supplementation, the researchers concluded:

"Supplementation to patients with chronic heart failure did not increase ejection fraction but increased skeletal muscle energy-rich phosphagens and performance as regards both strength and endurance. This new therapeutic approach merits further attention."[10]

Another study looked at the effects of creatine supplementation on endurance and muscle metabolism in people with congestive heart failure.[11] In particular the researchers looked at levels of ammonia and lactate, two important indicators of muscle performance under stress. Lactate and ammonia levels rise as intensity increases during exercise and higher levels are associated with fatigue.

High-level athletes have lower levels of lactate and ammonia during a given exercise than non-athletes, as the athletes' metabolism is better at dealing with these metabolites of exertion, allowing them to perform better. This study found that patients with congestive heart failure given 20 grams of creatine per day had greater strength and endurance (measured as handgrip exercise at 25%, 50% and 75% of maximum voluntary contraction or until exhaustion) and had lower levels of lactate and ammonia than the placebo group. This shows that creatine supplementation in chronic heart failure

augments skeletal muscle endurance and attenuates the abnormal skeletal muscle metabolic response to exercise.

It is important to note that the whole-body lack of essential high energy compounds (e.g. ATP, creatine, creatine phosphate, etc.) in people with chronic congestive heart failure is not a matter of simple malnutrition, but appears to be a metabolic derangement in skeletal muscle and other tissues.[12] Supplementing with high energy precursors such as creatine monohydrate appears to be a highly effective, low cost approach to helping these patients live more functional lives, and perhaps extend their life spans.

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Part III

Effects on growth hormone (GH)

Although data is limited, some research suggests creatine can raise growth hormone equal to that of intense exercise. Growth hormone (GH) is known to play an essential role in the regulation of body fat levels, immunity, muscle mass, wound healing, bone mass and literally thousands of other functions both known and yet unknown. It is well established that GH levels steadily decline as we age and is partially responsible for the steady loss of muscle mass, loss of skin elasticity, immune dysfunction and many other physical changes that take place in the aging human body. Therefore, the possible effects of creatine on GH is worth exploring in aging populations.

One study found creatine could mimic the increased GH levels seen after intense exercise.[1] In this comparative cross-sectional study, researchers gave six healthy male subjects 20 grams of creatine in a single dose at resting (non-exercising) conditions. The study found that all subjects showed a "significant" increase of GH in the blood during the six-hour period after creatine ingestion. However, the study also found "a large interindividual variability in the GH response." That is, there were wide differences among individuals in the levels of GH achieved from taking the creatine. For the majority of subjects the maximum GH concentration occurred between two and six hours after ingesting the creatine. The researchers concluded:

"In resting conditions and at high dosages creatine enhances GH secretion, mimicking the response of strong exercise which also stimulates GH secretion."

These researchers felt that the effects of creatine on GH could be viewed as one of creatine's anabolic properties with the lean mass and strength increases observed after creatine supplementation. Although creatine supplementation has been found to increase lean muscle mass and strength in many studies, the effects of creatine on those tissues via GH enhancement has yet to be elucidated.

Creatine may reduce homocysteine levels

Homocysteine has been recognized as an important independent risk factor of heart disease, more so than cholesterol levels according to some studies. Creatine biosynthesis has been postulated as a major effector of homocysteine concentrations,[2] and oral creatine supplements may reduce levels of homocysteine. Many studies have found that methyl donors (such as trimethylglycine (TMG) reduce levels of homocysteine,

which also reduces the risk of heart disease. Conversely, pathways that demand large amounts of methyl groups may hinder the body's ability to reduce homocysteine levels. The methylation of guanidinoacetate to form creatine consumes more methyl groups than all other methylation reactions combined in the human body. Researchers have postulated that increasing or decreasing methyl demands on the body may increase or decrease homocysteine levels. In one study researchers fed rats either guanidinoacetate- or creatine-supplemented diets for two weeks.[3] According to the researchers:

"...plasma homocysteine was significantly increased (~50%) in rats maintained on guanidinoacetate-supplemented diets, whereas rats maintained on creatine-supplemented diets exhibited a significantly lower (~25%) plasma homocysteine level."

These results suggest that homocysteine metabolism is sensitive to methylation demand imposed by physiological substrates such as creatine.

Creatine and chronic fatigue/fibromyalgia

Because of creatine's apparent abilities to improve the symptoms of other pathologies involving a lack of high energy compounds (e.g., congestive heart failure, etc.) as well as the aforementioned afflictions outlined in the introduction to this article, it has been suggested that creatine may help with chronic fatigue syndrome and fibromyalgia (some researchers now posit that they are in fact the same syndrome).

Although the causes of both pathologies are still being debated, a lack of high energy compounds (e.g. ATP) at the level of the mitochondria and general muscle weakness exists. For example, people with fibromyalgia have lower levels of creatine phosphate and ATP levels compared to controls.[4] No direct studies exist at this time showing creatine supplementation improves the symptomology of either chronic fatigue or fibromyalgia.

Considering, however, the other data that finds that creatine supplementation increases creatine and ATP levels consistently in other pathologies where low levels of creatine and ATP are found, it stands to reason that people suffering from either syndrome may want to pursue the use of creatine. Another similar syndrome to chronic fatigue and fibromyalgia, is Multiple Chemical Sensitivity Syndrome, which may also be potentially improved by the use of creatine supplements, though more research is clearly needed.

Creatine safety issues: fact or fiction?

Fears over the safety of creatine are usually generated from some hysterical news report or poorly researched article. It's odd, but predictable that the media and conservative medical establishment have desperately tried to paint creatine as an inherently dangerous or "poorly researched" dietary supplement. The fact is, creatine may be the most extensively researched performance enhancing supplement of all time, with a somewhat astounding safety record. True to form, the "don't confuse us with the facts" media and anti-supplement conservative medical groups have had no problems ignoring the extensive safety data on creatine, or simply inventing safety worries where none exists.

A perfect example of this was the news report that mentioned the deaths of three high school wrestlers who died after putting on rubber suits and riding a stationary bike in a sauna to lose weight. Amazingly, their deaths were linked to creatine by the media, rather than extreme dehydration!

Even more amazingly, on further examination, it was found that two of the three wrestlers were not using creatine!

Creatine has been blamed for all sorts of effects, from muscle cramps to dehydration, to increased injuries in athletes. However, these effects have been looked at extensively by researchers without a single study reporting side effects among several groups taking creatine for various medical reasons over five years.[5-8]

In some, but not all people, creatine can raise a metabolic byproduct of creatine metabolism known as creatinine. Some people–including some medical professionals who should know better–have mistakenly stated that elevated levels of creatinine could damage the kidneys.

Elevated creatinine is often a blood indicator, <u>not a cause,</u> of kidney dysfunction. That's a very important distinction, and several short- and long–term studies have found creatine supplements have no ill effects on the kidney function of healthy people.9,10 Though it makes sense that people with pre-existing kidney dysfunction should avoid creatine supplements, it is reassuring to know that creatine supplements were found to have no ill effects on the kidney function of animals with pre-existing kidney failure, showing just how non-toxic creatine appears to be for the kidneys.[9-11]

Bottom line, creatine safety has been extensively researched and is far safer than most over-the-counter (OTC) products, including aspirin.

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Part IV

Recommended doses

Although the doses used in some studies were quite high, recent studies suggest lower doses are just as effective for increasing the overall creatine phosphate pool in the body. Two to three grams per day appears adequate for healthy people to increase their tissue levels of creatine phosphate. People with the aforementioned pathologies may benefit from higher intakes, in the 5-to-10 grams per day range.

To load or not to load, that is the question…

One question that often comes up regarding Creatine is whether or not the loading phase is required. Originally the advice for getting optimal results was to load up on Creatine followed by a maintenance dose there after. This advice was based on the fact that the human body already contains approximately 120 grams of Creatine (as Creatine and Creatine phosphate) stored in tissues and to increase total Creatine stores, one had to load for several days in order to increase those stores above those levels.

The idea also seemed to work well in practice with people noticing considerable increases in strength and weight during the loading phase. All was not perfect however as many people found the loading phase to be a problem, with gastrointestinal upset, diarrhea and other problems. At the very least, loading was inconvenient and potentially expensive.

The need for a loading phase was a long held belief, but is it really needed to derive the benefits of Creatine? The answer appears to be no as both research and real world experience have found the loading phase may not be needed after all. A 1996 study compared a loading phase vs. no loading phase 31 male subjects.

The subjects loaded for 6 days using 20 g/day and a maintenance dose 2 g/day for a further 30 days. As expected, tissue Creatine levels went up approximately 20% and the participants got stronger and gained lean mass. Nothing new there! And, not surprisingly, without a maintenance dose Creatine levels went back to normal after 30 days.

Then the group was given 3g of Creatine without a loading dose. The study found a similar – but more gradual – increase in muscle Creatine concentrations over a period of 28 days. The researchers concluded:

"...a rapid way to Creatine load human skeletal muscle is to ingest 20 g of Creatine for 6 days. This elevated tissue concentration can then be maintained by ingestion of 2 g/day thereafter. The ingestion of 3 g Creatine/day is in the long term likely to be as effective at raising tissue levels as this higher dose."

A more recent study done in 1999 found that 5 g of Creatine per day without a loading phase in 16 athletes significantly increased measures of strength, power, and increased body mass without a change in body fat levels (whereas the placebo group showed no significant changes).

The researcher of this 1999 study concluded:

"...these data also indicate that lower doses of Creatine monohydrate may be ingested (5 g/d), without a short-term, large-dose loading phase (20 g/d), for an extended period to achieve significant performance enhancement."

So, don't suffer through the loading, thinking it's the only way to maximize the effects of your Creatine , it appears a 3 - 5 gram per day dose over and extended period of time will probably do the same thing.

Creatine and athletics

It's only normal for people writing about a compound that is well accepted by athletes and researchers alike to assume that everyone understands what this particular product is and what it does. However, I am quite sure there are plenty of people who have heard the word "creatine," or might even be using the stuff, and still don't have a clue what it is and how it works. If you are one of those people, the beginning of this section is for you.

As mentioned in previous sections, the body uses the high energy compound adenosine triphosphate (ATP) as its main energy producing compound. During short maximal bouts of exercise such as weight training or sprinting, stored ATP is the energy source. However, stored ATP is depleted rather quickly which is why after only a few reps on a heavy lift things come to a fast finish and you run out of steam. To give energy, ATP loses a phosphate and becomes adenosine diphosphate (ADP). At this point the ADP must be converted back to ATP to derive energy from this ATP energy producing system. So how does this happen? That's where creatine comes in. Creatine is stored in the human body as creatine phosphate (CP) also called phosphocreatine.

When ATP is depleted, it can be recharged by creatine phosphate. That is, the CP

donates a phosphate to the ADP making it ATP again! Got all that? An increased pool of CP means faster and greater recharging of ATP and therefore more work can be performed for a short duration, such as sprinting, weight lifting, and other explosive anaerobic endeavors. Now of course the above explanation of how creatine works was highly simplified and there are many other biochemical functions going on (e.g. possible increases in protein synthesis, increased cell hydration, and others) relating to creatine's ability to enhance strength, muscle growth, and performance, but the above explanation is basically the way it works.

Creatine works to increase strength and performance in sports that require short duration high intensity performance, such as sprinting, football, and weight training. It's much less effective for endurance sports such as long distance running, but may still have some beneficial effects that are outlined in this report, such as the research showing reduced inflammation after long distance running. Research that has looked at creatine's effects endurance sports has not been impressive however. Bodybuilders tend to love creatine, football players and sprinters like creatine, and swimmers and runners tend to have mixed opinions, so this pretty much keeps in sink with the research findings to date.

The creatine and sugar story

As mentioned above, creatine can definitely increase lean body mass (muscle) and improve performance in sports that require high intensity intermittent exercise such as the aforementioned sprinting, weight lifting, etc. However, creatine was found to be not effective on some people (approximately 30% of the people studied). Scientists theorized then that combining creatine with a simple sugar which would cause an insulin spike, might dramatically enhance creatine uptake into muscles and thus more creatine would be stored.

The main job of insulin is to control blood sugar by storing it in various compartments in the body (i.e. in muscle as glycogen and in fat cells as triglycerides). When blood sugar rises quickly, the body releases insulin to bring the blood sugar down. In the process of the blood sugar being taken up by muscle cells via insulin secretion (not to be confused with non-insulin dependent uptake that takes place immediately after workouts), all sorts of things found in the blood stream such as vitamins, amino acids, and minerals sort of go along for the ride with the glucose. That's a great over simplification of a complex system, but that's basically it in a nut shell minus the highly technical mumbo jumbo.

These "non-responders" appeared not to store creatine well from an oral supplement.

When these non-responders were given creatine plus the simple sugar dextrose– which is just another term for glucose – these people were able to take up the creatine effectively. So, creatine plus dextrose was found to dramatically reduced the number of people who didn't respond well to creatine alone. Further research found that even the people who responded well to oral creatine ingestion responded even better if the creatine was mixed with this simple sugar. In some cases there was a 60% improvement in creatine uptake. People given this combination had greater increases in lean muscle mass and even improved performance over creatine alone.

Pre-made creatine/sugar mixtures

Various companies combine dextrose with creatine and sell it as a single product. Also, they often add in other ingredients that might be helpful for increasing creatine uptake, lean body mass, and performance, such as glutamine, taurine, and various vitamins.

However, research showing these products are superior to simple creatine and glucose mixtures is lacking. Some people just make their own by mixing the creatine in a glass of grape juice, but of course grape juice is not all glucose (it also contains fructose) and does not contain the other ingredients that some products offer the user may want. None the less, many people feel they get good results just going the grape juice and creatine route. I often recommend half an *Ultra Fuel* mixed with creatine.

Purity issues

There has been much made about creatine purity, mostly due to an article I did some time back that exposed the fact that not all creatine is created equal. The article can be viewed on my website, the BrinkZone (www.brinkzone.com).

So who tested out the best at the time that article was written? It's now sold to companies as Creapure, so if you see on the can of creatine the company uses Creapure creatine as their source, that's the good stuff. Most companies using Creapure as their source list it on the bottle of product.

So who sells Creapure brand creatine?

Below are a few companies that use Creapure:
Life Extension Foundation
Ultimate Nutrition
Prolab
ISS

Kaizen
Reflex

Note: There are **many more** companies that use Creapure, so your choices are not at all limited to the above companies. A quick search in Google or at online supplement store will give you a large number of options to choose from.

Additional references of interest

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Conclusion

Creatine is quickly becoming one of the most well researched and promising supplements for a wide range of diseases and many other health/fitness concerns. It may have additional uses for pathologies where a lack of high energy compounds and general muscle weakness exist, such as fibromyalgia.

People with fibromyalgia have lower levels of creatine phosphate and ATP levels compared to controls. Though additional research is needed, there is a substantial body of research showing creatine is an effective and safe supplement for a wide range of pathologies and is clearly the next big find in anti-aging nutrients.

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Brink's Body Building Revealed was devised by author, researcher, and trainer Will Brink. It's the most complete e-book on the market on the science of bodybuilding nutrition, supplementation and training.

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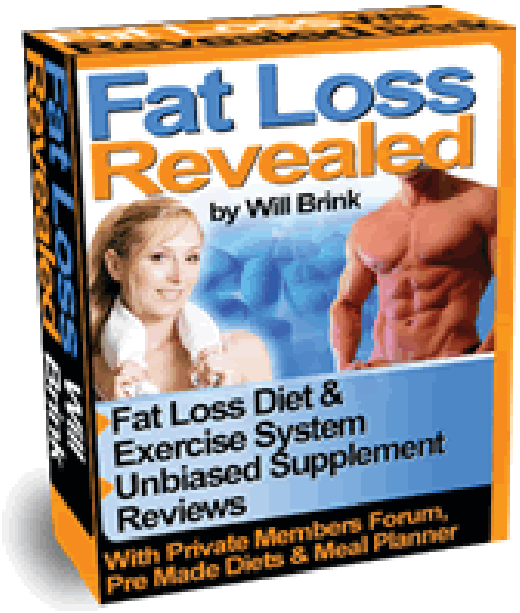
Hope to see you in the Members' Area!

Fat Loss Revealed



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- Find solid information on cardio and strength exercise routines, complete with photos, videos and explanations along with charts you can download to monitor your progress
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