

“Creatine”

Penny Heyns uses it and she is a good, clean-living young lady who has recently set a spate of world records.

Many of the top rugby and soccer players-role models to our sporting school children- use it and extol its virtues. It has been dubbed as “Nature’s own anabolic steroid”; is freely available and “without any known side effects”.

Is it the ultimate panacea and sports supplement? Shouldn’t we all be using it? How can you as a sportsperson compete if you don’t use it when your competitors are doing so?

I have tried to make some sense of the articles below and the following is a distillation of this bibliography.

What is creatine and what does it do? Creatine is a physiologically active substance indispensable to muscle contraction. In the form of creatine phosphate it is an important store of energy in muscle cells.

- Our knowledge concerning creatine dates back to 1835.
- It is synthesized from amino acids glycine, arginine and methionine in the kidneys, liver and pancreas.
- It is predominantly found in the skeletal muscle- approx 40% in the free form and 60% as creatine phosphate.
- Daily turnover is approximately 2g both from ingestion and endogenous synthesis.
- Dietary intake is mainly from animal products –fish and meat.
- Oral creatine supplements are ingested as creatine monohydrate.

PHYSIOLOGY

We require energy to make our heart beat, our brains function and our muscles work. All our chemical processes require energy. Our body has to transform the food we eat into a useable form of energy. Physical activity demands a great amount of energy. This demand can be up to 120 times higher than at resting levels. Our source of energy is food that we

ingest and this provides the energy that keeps our engine ticking over. Muscle tissue converts chemically bound energy to kinetic energy which is used in muscle contraction.

The Primary source of energy exists in the form of Adenosine Triphosphate (ATP). This energy is released when ATP is hydrolysed to Adenosine Diphosphate (ADP) and inorganic phosphate at the cross bridges of the myofibrillar proteins in the actomyosin complex.

ATP is constantly being used up and replenished by the energy systems in our body.

Energy utilisation in the body is via aerobic or anaerobic metabolism.

There are broadly speaking three energy systems in the body:

1. The immediate energy system or the ATP- Creatine phosphate energy system
2. The Short term or lactic acid / anaerobic system and
3. The aerobic system or the longterm system

Which system is used depends upon the intensity and duration of the exercise.

The major sources of chemical energy for ATP resynthesis are lipids and carbohydrates.

IMMEDIATE ENERGY (ATP - CP system)

Short duration exercise and exercise requiring brief maximal effort, requires an immediate supply of energy which is obtained almost exclusively from the high energy phosphates (ATP and CP) stored in the muscles.

We have stores for approximately one minute of brisk walking or sprinting for six seconds. The quantity of intramuscular phosphates may significantly influence the ability to generate intense

energy for a short duration.

Creatine phosphate comes into play for immediate energy needs and provides the energy for the first few seconds.

Thus it is important in sprinting and power events.

SHORT TERM ENERGY (Lactic Acid System)

For exercise to continue beyond a brief period of time, high-energy phosphates must be continually resynthesised. This energy comes from the glucose and stored glycogen during the anaerobic process of glycolysis with the resultant formation of lactic acid. During glycolysis the energy released is rapid and does not require oxygen, but little ATP is resynthesised.

LONG TERM ENERGY (Aerobic System)

Aerobic reactions provide the final important stage for energy transfer.

THE ENERGY SPECTRUM OF EXERCISE

During strength and power sprint activities, the primary energy transfer involves the immediate and short term energy systems. The long-term aerobic energy system becomes progressively more important in activities lasting longer than 2 minutes.

During intense exercise of +/- 2 minutes (e.g. sprinting) we use the:

1. Immediate and
2. Short term energy systems.

At the initiation of movement - stored phosphates (ATP and CP) provide immediate energy for muscle contraction.

Half of the energy is obtained from the ATP-CP system and half from the anaerobic system.

Intermediate exercises of 5 to 10 minutes (eg. soccer, basket-ball) - the energy is supplied mainly from the anaerobic reactions.

Long duration exercises (eg. marathon running) - mainly aerobic energy, with minimal lactic acid production.

For example, the percentage of energy contributed to ATP generation in the following events has been estimated as the following:

Event	Immediate	Short	Long
100m	50%	50%	-
5000m	*	12,5%	87,5%
Soccer	10%	70%	20%

* Creatine phosphate is used in the first few seconds and if it has been resynthesised during the race, in the sprint to the finish.

HENCE WE CAN SEETHATTHE USE OF CREATINE SHOULD INFLUENCE THE IMMEDIATE ENERGY TRANSFER SYSTEM and this seems to correlate with findings in research.

The rationale behind the use of creatine supplementation is:

An improved capacity for energy transfer usually translates into improved exercise performance. As phosphocreatine stores become depleted, output power is reduced as ATP cannot be regenerated fast enough. This results in muscle fatigue. If ingesting creatine can improve energy transfer, exercise performance will improve.

What is known?

Training does not appear to affect creatine levels in the muscles, but supplementation does increase concentrations of free creatine and creatine phosphate.

How does creatine work?

- It works by increasing muscle creatine and phosphocreatine.
- This leads to a higher rate of ATP resynthesis.
- This results in a delay in onset of muscular fatigue.
- It facilitates recovery during repeated bouts of high intensity exercise.
- Creatine improves strength by increasing myofibrillar protein synthesis.
- Resistance training and longterm creatine supplementation = increased muscle creatine = increased training intensity, greater training stimulus = improved physiological response-training effect.

Ergogenic effects of Creatine

- It improves performance in repeated sprints.
- Single competition events do not seem to benefit.
- Improves performance in high intensity short term exercise tasks that are dependent primarily upon creatine i.e. less than 30 seconds, especially where recovery time between bouts of exercise is limited. e.g. cycling, sprinting, swimming, kayaking, jumping and weightlifting.
- Improves work performance.
- Improves power and strength.
- No ergogenic effects on submaximal or endurance sports have been recorded.
- Increases time to fatigue, and maximal strength in large muscle group.
- Enhances maximal strength, body mass, fat free mass.
- Creatine supplementation enhances muscle morphology when used with heavy resistance training.
- Increases areas of muscle fibre in men.
- Not all studies show benefits.
- There can be marked individual variation.

Side effects:

- Increase in mass in short-term, possibly due to water retention (1-2kg).
- Minor gastrointestinal upset.

Safety:

It does not appear to have any effect on the kidney, or haematological parameters in healthy subjects.

People with preexisting renal conditions may be at risk for deterioration of renal function.

No long-term studies are as yet available and most authors advise caution. However creatine has been used as a nutritinal supplement for 10 years or more, and as yet there are no documented long-term significant side-effects

There are anecdotal reports of other side-effects, such as cramping and a greater incidence of muscle strains, but these have not been adequately documented.

It is not recommended for adolescents, but the basis for this recommendation appears to be more that there have not been any long-term studies performed in this group, rather than any detrimental effects reported in this age group.

Dosages:

5g of creatine monohydrate increases blood creatine levels nearly 10-fold. Ingesting 5g 4-5 times daily over 5-7 days increases uptake of creatine into muscle by as much as 30%.

Lower doses of 3g per day also increase muscle creatine, but gradually over weeks. Hence, loading doses are usually used for 5 -7 days at 5g 4 times a day, or at 0.25 -0.3 g per kg in divided doses. This is followed by maintenance doses of 3 - 6 g daily. Ingestion of a carbohydrate solution with the creatine improves the variability of uptake.

Normal concentrations of creatine in skeletal muscle are 120mmol/kg (range 110-150mmol/kg).

The upper limit of creatine accumulation is approx 155-160mmol/kg.

Dosages vary and many different dosage regimens have been tried and are being studied. A fairly common dosage schedule appears to be 20-25g per day daily loading dose for 5-7 days, followed by a continuous maintenance dose of 5g a day

In summary;

- Creatine does help power and immediate energy supply.
- It appears safe.
- It appears most useful where repeated short sprints or power-type energy requirements are required.
- Individual response varies greatly. There seem to be responders and non-responders.
- Side-effects appear to be only short-term weight gain due to fluid retention.
- Elite athletes could benefit from creatine because of the increased ability to perform repeated high-intensity exercise bouts, either during training or competition.
- In adults, if you can afford it, it appears to do good with no harm.
- It is also currently a legal supplement.

Bibliography:

1. Newsholme et al. Physical and mental fatigue: metabolic mechanisms and importance of plasma amino acids. *Br. Med. Bull.*, 48:477,1992.
2. Peyrebrune MC; Neville ME; Donaldson FJ; Cosford DJ. The effects of oral creatine supplementation on performance in single and repeated sprint swimming. *J Sports Sci*, 16(3): 271-9 1998 Apr.
3. Burke LM.; Pyne DB; Telford RD. Effect of oral creatine supplementation on single - effort sprint performance in elite swimmers.
4. Bolotte CP Creatine supplementation in athletes; benefits and potential risks. *J La State Medical Society*, 150(70):325-7, 1998 Jul
5. Kraemer WJ, Volek JS. Creatine supplementation. Its role in human performance. *Clinics in Sports Medicine*. 18(3); 651-66,ix,1999 Jul.
6. Kreider RB et al. Effects of creatine supplementation on body composition, strength and sprint performance. *Medicine & Science in Sports & Exercise*. 30(1);73-82, 1998 Jan.
7. Poortmans JR, Francaux M. Long -term oral creatine supplementation does not impair renal function in healthy athletes. *Medicine & Science in Sports & Exercise*. 31(8): 1108-10,1999 Aug.
8. LaBotz M Smith BW Creatine supplement use in an NCAA Division I athletic program. *Clinical Journal of Sport Medicine*. 9(3): 167-9, 1999 Jul.
9. Kraemer WJ, Volek JS. Creatine supplementation. Its role in human performance. *Clinics in Sports Medicine*. 18(3); 651-66,ix,1999 Jul.
10. Kreider RB et al. Effects of creatine supplementation on body composition, strength and sprint performance. *Medicine & Science in Sports & Exercise*. 30(1);73-82, 1998 Jan.
11. Kreider, RB. 1998. Creatine, the Next Ergogenic Supplement? *Sportscience training & technology*. Internet Society for Sport Science. <http://www.sportsci.org/traintech/creatine/rbk.html>.
12. Aaserud R, Gramvik P, Olsen SR, Jensen J. Creatine supplementation delays onset of fatigue during repeated bouts of sprint running. *Scandinavian Journal of Medicine & Science in Sports*. 8(5 Pt 1):247-51,1998.
13. McNaughton LR, Dalton B, Tarr J. The effects of creatine supplementation on high-intensity exercise performance in elite performers. *European Journal of Applied Physiology & Occupational Physiology*. 78(3):236-40, 1998
14. Williams MH, Branch JD. Creatine supplementation and exercise performance: an update. *Journal of the American College of Nutrition*. 17(3):216-234,1998 Jun.
15. Snow RJ et al. Effect of creatine supplementation on sprint exercise performance and muscle metabolism. *Journal of Applied Physiology*. 84(5):1667-73,1998 May
16. Juhn MS, Tarnopolsky M. Oral creatine supplementation and athletic performance: a critical review. *Clinical journal of Sport medicine*. 8(4): 286-97, 1998 Oct.
17. Leenders NM, Lamb DR, Nelson TE. Creatine supplementation and swimming performance. *International Journal of Sport Nutrition*. 9(3):251-62, 1999 Sep.
18. Kreider RB et al. Effects of creatine supplementation on body composition, strength and sprint performance. *Medicine & Science in Sports & Exercise*. 30(1);73-82, 1998 Jan.
19. Mujika I, Padilla S. Creatine supplementation as an ergogenic aid for sports performance in highly trained athletes: a critical review. *International Journal of Sports Medicine*. 18(7): 491-6, 1997.
20. Rossiter HB, Cannell ER, Jakeman PM. The effect of oral creatine supplementation on the 1000-m performance of competitive rowers. *Journal of Sports Sciences*. 14(2): 175-9,1996 Apr
21. Smith SA et al. Effects of creatine supplementation on the energy cost of muscle contraction: a ³¹P-MRS study. *Journal of Applied Physiology*. 87(1):116-23,1999 Jul.
22. Urbanski RL, Vincent WJ, Yaspelkis BB. Creatine supplementation differentially affects maximal isometric strength and time to fatigue in large and small muscle groups. *International Journal of Sport Nutrition*. 9(2); 136-45, 1999 Jun.
23. Engelhardt M, Neumann G, Berball A, Reuter I. Creatine supplementation in endurance sports. *Medicine & Science in Sports & Science*. 30(7):1123-9,1998 Jul.
24. Aaserud R, Gramvik P, Olsen SR, Jensen J. Creatine supplementation delays onset of fatigue during repeated bouts of sprint running. *Scandinavian Journal of Medicine & Science in Sports*. 8(5 Pt 1):247-51,1998.
25. Kraemer WJ, Volek MS. Creatine Supplementation. *Current Comment from American College of Sports Medicine*. June 1998.

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