

Trends in Creatine Supplementation for Athletes: A Systematic Review

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Abstract: *Research on creatine supplementation among athletes and in sports has been extensive over the years. Numerous studies have investigated the effects of creatine supplementation on various aspects of athletic performance, muscle physiology, and health. In this review, studies over the years have been highlighted to show the positive and negative effects of Creatine Monohydrate, commonly known as creatine supplementation in various kind of sports among the athletes which includes both, physical and cognitive performance.*

Keywords: Creatine Monohydrate, Supplementation, Athlete, Sports, Cognitive performance

1. Introduction

Creatine is a naturally occurring compound found in small amounts in certain foods and is also synthesized by the body. It plays a crucial role in providing energy for short bursts of intense physical activity, making it a popular choice among athletes aiming to enhance their performance during activities such as weightlifting, sprinting, and other high-intensity exercises and thus being the most popularly studied energy supplement [1].

In the 1990s, creatine gained significant attention and popularity in the sports and fitness communities due to studies suggesting its potential benefits in improving strength gains and performance during short, high-intensity exercises. This led to widespread use of creatine supplements among athletes who were engaged in resistance training and other activities that required bursts of power and energy such as sprinting, weight-lifting and jumping [2, 3]. Around 300 studies show that use of creatine in resistance training has increased the strength of the athletes up to 70 percent [4].

Popularity of creatine continued to be evident as studies pointed to its potential benefits and as more athletes incorporated it into their training regimens. However, over time, the popularity of dietary supplements can shift due to various factors, including changing research findings, new trends in the fitness industry, and the introduction of new products. The theory behind creatine supplementation is to maximize creatine stores in individuals with lower initial levels of creatine in their muscles [5]. For these individuals, supplementing with oral creatine can lead to the most substantial increase in intramuscular creatine stores [5]. This increase in stores can aid in ATP and phosphocreatine production, helping to delay the onset of muscle fatigue during short, high-intensity efforts.

In more recent years, surveys have indicated a potential decrease in the popularity of creatine as other supplements, such as whey protein, gained prominence [6,7]. This could be attributed to changing preferences among athletes, evolving marketing strategies, and advancements in sports nutrition research. Emerging research suggests that creatine

might offer neuroprotective benefits by providing energy support to brain cells and enhancing their resistance to stressors [8, 9]. This could have implications for cognitive function and brain health [8, 9].

Trends in the use of dietary supplements can continue to change, and new research findings can also impact the perception and adoption of these supplements among athletes.

2. Observation

Several studies have been conducted to observe the effects of creatine or creatine monohydrate supplementation among athletes in various sports throughout the world. In a study conducted among national and international level sprinters, throwers, weightlifters, and football players it was noticed that long term creatine supplementation did not impose any hazardous health effects among the individuals that were considered in the study [10]. Sixty five variables were considered in the study which included blood analysis and also study of the side effects. The study showed no alteration in serum enzymes. A minor increase in serum creatinine was observed. The study has also reported enhanced protein synthesis which could be a result of creatine action upon the cells. The study showed no possibility of muscle cramps due to creatine ingestion [10]. In contrary, another study showed clearly that there is no increase in muscle protein synthesis with intake of creatine [11].

In a study by Greenwood et al. two hundred and nineteen male and female collegiate athletes were chosen as subjects of study representing eight university sports [12]. The study was conducted with the help of a questionnaire consisting questions of their daily pattern in using creatine supplementation. Though the survey found people reporting positive effects (strength, weight gain), it also registered reports on negative effects (cramps, gastrointestinal disorder) as a result of creatine supplementation.

A study [13] was conducted among athletes performing in endurance sports. After a pretreatment exercise test the athletes ingested 6gm of creatine daily, divided into two portions, for 5 days. On day 6, a different exercise test was

performed. A significant fall in blood glucose was observed after exercise test due to consumption of creatine supplement prior to the test. Though creatine was found to have no influence on endurance performance, it was found to have a significant one on interval power performance. Creatine supplementation was found to have no influence on the cardiovascular system, oxygen uptake, and blood lactate concentration.

Maintenance of muscular force and power output is greatly enhanced by short term creatine supplementation during cycling, running, jumping, kayaking. Most of the studies [14] on creatine supplementation examining exercise performance involved doses of 20-30 gm/ day for about 5-7 days.

Several studies reported an increase in fat free muscle mass with creatine supplementation, mostly in combination with resistance exercises [15]. Some indirect evidences on the basis of mRNA analysis revealed that there was enhancement of transcription of several genes upon creatine supplementation [10]. Healthy subjects had no issues with their renal function upon creatine supplementation although it is mostly recommended to limit the usage for the ones with pre-existing kidney problems [10].

In a study [16] with 36 male tennis players, it was found that creatine supplementation had no significant role in increasing repetitive sprint power and is best not recommended for tennis players. Post exercise consumption of creatine was considered superior than pre workout for building of strength [15].

In another study [17], 7 female and 8 male swimmers were selected. Few of them supplemented with creatine (0.3 gm creatine/kg body mass) and others were on placebo. The finish time was found to decrease for the ones who had consumed creatine in comparison to the placebo.

In a randomized study [18], it was found that Creatine monohydrate supplementation prevented the decrement in lower-limb muscle power in elite soccer players during a pre-season progressive training. Also a randomized clinical trial [19], was conducted with 30 female futsal players aged around 19, and was found that their performance, leg strength and agility had improved on supplementation with creatine (0.25 gm/kg/day micronized pure creatine monohydrate) without any significant increase in weight.

In an animal study [20], with rats it was concluded that oral creatine supplementation along with moderate exercise training resulted in renal and hepatic function challenge.

Although effect of creatine supplementation on aerobic performance is still a debatable one, in many studies performed among soccer players showed that it has helped in increasing training volume which has led to gain in strength, power and muscle mass [8, 21, 22].

Studies [20, 21] have also shown that creatine has helped in improving sports performance by providing a mental boost to the athletes. It has a positive effect on both working memory and intelligence [21].

When consumed within the recommended range it is considered to be safe, although a temporary discomfort in the stomach and weight gain has been noticed in a significant number of studies [23, 24, 25].

3. Mode of Action

Creatine is converted into phosphocreatine within muscle cells. Phosphocreatine serves as a rapidly available reservoir of high-energy phosphate groups that can be used to regenerate adenosine triphosphate (ATP) during short bursts of intense activity. ATP is the primary energy currency of cells, and having more phosphocreatine available allows for more rapid ATP regeneration [2, 3].

During high-intensity activities like weightlifting or sprinting, the demand for ATP is high. The breakdown of ATP provides the energy needed for muscle contractions. Creatine supplementation enhances the rate of ATP regeneration from ADP (adenosine diphosphate) using the phosphate group stored in phosphocreatine. This effectively extends the duration of maximal or near-maximal effort [2, 3].

The enhanced availability of ATP due to increased phosphocreatine stores allows athletes to perform more repetitions, generate more force, and sustain high-intensity efforts for a longer duration. This is particularly beneficial for sports and activities that involve short bursts of explosive power.

Creatine supplementation can lead to intracellular water retention within muscle cells [26]. This cell swelling, although temporary, can contribute to an increase in muscle size, also known as hypertrophy. Additionally, this environment might stimulate protein synthesis, promoting the growth and repair of muscle tissue. It can also affect myogenesis by altering the secretions of myokines [26].

During intense exercise, the accumulation of lactic acid in muscles can lead to fatigue. Creatine's ability to regenerate ATP quickly helps maintain cellular pH balance, which may help buffer the buildup of lactic acid and delay the onset of fatigue.

Creatine has been shown to have antioxidant properties, which could reduce oxidative stress and muscle damage resulting from intense exercise [27]. This may contribute to faster recovery and reduced inflammation [27].

4. Conclusion

Therefore, from various studies, it may be inferred, that Creatine supplementation has consistently demonstrated improvements in power, strength, and performance during high-intensity, short-duration activities. Recent findings have also been more focused on the role of creatine in improving or boosting the function of the brain as well. Moreover it was found to have mild side effects.

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