The Effects of Creatine Supplementation on Biochemical, Body Composition, and Performance Outcomes in Humans: A Meta-analysis

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Creatine supplementation has been widely used for athletes and in some studies it has been proved effective; however, there remain some moderator variables that still require meta-analysis. Therefore, the purpose of this study was to conduct such an analysis on the effects of creatine supplementation on biochemical, body composition, and physical performance variables. From a total of 120 experimental studies found in databases, only 55 studies (46%) were considered appropriate and/or contained the necessary information to obtain effect sizes. Creatine supplementation produced biochemical changes, including increases in excretion parameters. Anthropometric variables, body fat percentage, and lean mass were favorably changed by creatine supplementation. Improved peak power, total work, force power, and a maximal repetition (1RM) were also found following creatine supplementation. There was an evident placebo effect in the variables meta-analyzed; however, there was a clear increase in total work beyond the placebo effect. In summary, creatine supplementation consistently showed positive biochemical, body composition, and power changes in humans.

key words: Meta-analysis, Creatine, Power, Body Composition, Placebo, Placebo Effect, Nutritional Supplements

Introduction

During the late 80’s and the beginning of the 90’s it was common practice within professional and amateur athletes to consume several types of ergogenic substances. Creatine (Cr) was one of those substances aimed at inducing changes in strength, power, and body composition, and overall, to increase performance.

In a study with 229 physically-active participants (Sheppard, Raichada, Kouri,
Stenson-Bar-Maor, & Branch, 2000), it was found that 69% consumed a mean dose of 12.25 g Cr/day as a nutritional supplement. In another study (Schilling et al., 2001), it was reported that professional athletes of different sports consumed Cr for a period of time of 0.8 to 4 years. During that time, the athletes consumed a similar dose of 13.7 g Cr/day in the overload phase.

It has been demonstrated that Cr consumers are predominantly involved in strength and power activities (Sheppard et al., 2000). This can be explained by two reasons. First, the general perception of people of different ages at an anecdotal level is that Cr consumption allows increases in body mass and muscular force when combined with a strength training program (Gotshalk, Volek, Staron, Denegar, Hagerman, & Kramer, 2002; Juhn, 1999; Lamb, 1999; Poortmans & Francaux, 2000; Terjung et al., 2000). Secondly, the scientific literature that have found positive effects of Cr supplementation on physical performance variables have relied upon anaerobic intermittent and repetitive exercise performed at near or maximal capacity (e.g., 90-100% maximal oxygen consumption [VO2max]) for a short duration (e.g., < 1 min) (Dawson, Cutler, Moody, Lawrence, Goodman, & Randall, 1995; Gotshalk et al., 2002; Greenhaff, Bodin, Soderlund, & Hultman, 1994; Kamber, Koster, Kreis, Walker, Boesch, & Hoppeler, 1999; Kreider, Ferreira, Wilson, Grindstaff, Plisk, Reinardy, Cantler, & Almada, 1998; Preen, Dawson, Goodman, Lawrence, Beilby, & Ching, 2001; Prevost, Nelson, & Morris, 1997; Rossiter, Cannell, & Jakeman, 1996; Terjung et al., 2000; Volek, Kraemer, Bush, Boetes, Incledon, Clark, & Lynch, 1997).

Although some benefits of Cr supplementation have been reported on body composition and anaerobic endurance, these findings appear to be equivocal. For example, in several studies (Balsom, Söderlund, Sjödin, & Ekblom, 1995; Becque, Lochmann, & Melrose, 2000; Burke, Chilibeck, Davison, Candow, Farthing, & Smith-Palmer, 2001; Dawson et al., 1995; Green, Hultman, Macdonald, Sewell, & Greenhaff, 1996; Greenhaff et al., 1994; Kamber et al., 1999; Kreider et al., 1998; Maganaris & Maughan, 1998; Mihic, MacDonald, McKenzie, & Tarnopol'sky, 2000; Murphy, Watsford, Coutts, & Richards, 2005; Preen et al., 2001; Rebello-Mendes, Pires, Oliveira, & Tirapegui, 2004; Snow, McKenna, Kemp, Stathis, & Zhao, 1998; Volek, Duncan, Mazzetti, Staron, Putukian, Gómez, Pearson, Fink, & Kraemer, 1999; Volek, Duncan, Mazzetti, Putukian, Gómez, & Kraemer, 2000) changes in body composition were reported, specifically increases in lean and total body mass. According to Poortmans and Francaux (2000), other researchers, although in a