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# CREATINE SUPPLEMENTATION AND MULTIPLE SPRINT RUNNING PERFORMANCE

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**ABSTRACT.** Mark Glaister, Richard A. Lockey, Corinne S. Abraham, Allan Staerck, Jon E. Goodwin, and Gillian McInnes. Creatine supplementation and multiple sprint running performance. *J. Strength Cond. Res. 20(2):273–277. 2006.*—The aim of this study was to examine the effects of short-term creatine monohydrate supplementation on multiple sprint running performance. Using a double-blind research design, 42 physically active men completed a series of 3 indoor multiple sprint running trials (15 × 30 m repeated at 35-second intervals). After the first 2 trials (familiarization and baseline), subjects were matched for fatigue score before being randomly assigned to 5 days of either creatine ($4 \cdot d^{-1} \times 5$ g creatine monohydrate + 1 g maltodextrin) or placebo ($4 \cdot d^{-1} \times 6$ g maltodextrin) supplementation. Sprint times were recorded via twin-beam photocells, and earlobe blood samples were drawn to evaluate posttest lactate concentrations. Relative to placebo, creatine supplementation resulted in a 0.7 kg increase in body mass (95% likely range: 0.02 to 1.3 kg) and a 0.4% reduction in body fat (95% likely range: −0.2 to 0.9%). There were no significant ($p > 0.05$) between-group differences in multiple sprint measures of fastest time, mean time, fatigue, or posttest blood lactate concentration. Despite widespread use as an ergogenic aid in sport, the results of this study suggest that creatine monohydrate supplementation conveys no benefit to multiple sprint running performance.

KEY WORDS. intermittent ergogenic aid, repeated sprint, fatigue

## INTRODUCTION

During brief periods (≤ 10 seconds) of high-intensity exercise, intramuscular phosphocreatine (PCr) acts as a short-term energy buffer to maintain a rapid rate of adenosine triphosphate (ATP) turnover. As such, PCr availability is reported to be one of the main limiting factors during this type of work and, consequently, creatine supplementation, in the form of creatine monohydrate, has become a popular ergogenic aid for many athletes. A typical loading strategy of 20 $g \cdot d^{-1}$ for 5 days has been shown to significantly increase muscle PCr stores with the largest increases observed in individuals with initially low creatine levels, particularly vegetarians (22, 38).

One of the main ways in which creatine supplementation is thought to boost performance is by enhancing the rate of postexercise PCr resynthesis. Given the synchronous relationship between PCr resynthesis and the recovery of power output (6, 7, 13, 23, 41), this effect is most likely to benefit multiple sprint activities where performance depends, to a large extent, on the ability to recover between successive sprints. However, investigations into the effects of creatine supplementation on the rate of postexercise PCr resynthesis show some conflicting results (15, 18, 21, 29, 32, 36, 44, 47, 49). Moreover, although a number of investigations into creatine supplementation have reported significant improvements in the ability to maintain multiple sprint performance (1, 3, 9, 26, 27, 34, 49), others report no such effect (2, 5, 14, 15, 28, 30, 33, 43, 51). Therefore, despite widespread use among athletes, the effects of creatine supplementation on multiple sprint performance remain equivocal.

One of the main reasons for discrepancies in the results of investigations into the effects of creatine supplementation on multiple sprint performance is the use of relatively low subject numbers (≤16 subjects per group) (31). This is particularly important given the large intersubject variability in the response to creatine supplementation with approximately 20% of subjects termed 'nonresponders' (21, 22). Moreover, although most studies have adopted an independent group design, in many cases investigations have failed to match subjects on key dependent variables before randomization. The purpose of this study was to address those issues by examining the effects of creatine supplementation on multiple sprint performance using a sample size with sufficient power to detect a statistically significant treatment effect. The protocol was designed to simulate the type of activity pattern often experienced in field sports such as soccer, rugby, and hockey (4, 11, 35, 40, 45, 48).

## METHODS

### Experimental Approach to the Problem

A randomized, double-blind, placebo-controlled design was adopted for this investigation. Over a 4-week period, each subject completed 3 separate multiple sprint trials, each separated by at least 72 hours. Trial 1 ($T_1$) was a familiarization test to limit the effects of learning on the outcome of the experiment. Trial 2 ($T_2$) was a baseline test to enable subjects to be matched by fatigue score before randomization. Trial 3 ($T_3$) was the postsupplementation test. All trials were performed at approximately the same time of day. Subjects were instructed to maintain their normal diet throughout the testing period, to avoid food and drink in the hour before each trial, and to avoid strenuous exercise 24 hours before each trial.

### Subjects

Forty-two healthy, nonvegetarian, male, sport science students were recruited for the study, and all gave written informed consent before participation. Ethical approval was granted by the St. Mary's College ethics committee, and all subjects were given written and verbal instructions regarding the nature of the investigation. Before commencement, all subjects completed a training history questionnaire, which indicated that all had been actively involved in sport for approximately 13 years and that 88% were involved in some form of multiple sprint

**TABLE 1.** Subject characteristics (mean ± *SD*).

| Group | *n* | Age (yrs) | Height (m) | Body mass (kg) | Body fat (%)* |
|---|---|---|---|---|---|
| Creatine | 21 | 20 ± 1.0 | 1.79 ± 0.07 | 76.1 ± 10.2 | 15.0 ± 5.4 |
| Placebo | 21 | 20 ± 0.9 | 1.78 ± 0.06 | 76.2 ± 9.9 | 14.6 ± 4.1 |

* Note: Body fat was predicted from skin-fold measurements using the procedures outlined by Durnin and Womersley (16).

sport. Physical characteristics of the subjects are presented in Table 1.

### Supplementation

After $T_2$, subjects were administered 20 small grip-seal bags, each containing either 5 g creatine monohydrate plus 1 g maltodextrin (Starmax Nutrition, Hereford, UK), or 6 g maltodextrin. Subjects were instructed to mix the powder in warm water for immediate consumption at regular intervals 4 times per day for 5 days. This supplementation regime has previously been shown to be effective in elevating muscle PCr levels in young subjects (21, 22, 29, 44). Subjects were interviewed following the supplementation period to ensure compliance with the supplementation regime.

### Exercise Protocol

All testing was conducted indoors on a synthetic running surface. Before each multiple sprint test, subjects performed a standardized warm-up (approximately 5 minutes) comprising 600 m of jogging (self-selected pace), a series of sprint drills (high-knees and heel-flicks), and 3 practice sprints. Following the warm-up, subjects were given 5 minutes to stretch and prepare themselves for the multiple sprint test, which consisted of 15 × 30 m straight-line sprints repeated at 35-second intervals. Each sprint was initiated from a line 30 cm behind the start line (to prevent false triggering of the first timing gate) and times were recorded electronically via twin-beam photocells (Swift Performance Equipment, Lismore, Australia). Alternate sprints were performed in the opposite direction, thereby enabling subjects to maximize the available recovery time between sprints. Computer-generated audio signals provided a 5-second countdown to the start of each sprint and subjects were verbally encouraged to give maximal effort. In accordance with the recommendations made by Glaister et al. (20), fatigue during each test was calculated from 30-m sprint times using the performance decrement score devised by Fitzsimons et al. (17):

$$Fatigue = \left(\frac{Total\ sprint\ time}{Ideal\ sprint\ time} \times 100\right) - 100.$$

Where *total sprint time* = sum of all sprint times; and *ideal sprint time* = number of sprints × fastest sprint time.

In line with previous research using similar multiple sprint protocols (2, 17), the protocol used in this study showed a good level of test–retest reliability, with intraclass correlation coefficients for measures of fastest time and fatigue of 0.92 (95% likely range: 0.83 to 0.96) and 0.75 (95% likely range: 0.52 to 0.88), respectively.

In $T_3$, small pin-prick blood samples were obtained from hyperemized earlobes immediately after the multiple sprint test for lactate analysis via a hand-held Lactate Pro (Arkray; KDK Corporation, Kyoto, Japan). The reliability ($r$ = 0.99) and validity of this equipment has been reported previously (37).

**TABLE 2.** Presupplementation multiple sprint performance data (15 × 30 m; repeated at 35-second intervals). Values are mean ± *SD*.

| Group | *n* | Fastest time (s) | Mean time (s) | Fatigue (%) |
|---|---|---|---|---|
| Creatine | 21 | 4.31 ± 0.13 | 4.63 ± 0.14 | 7.42 ± 3.08 |
| Placebo | 21 | 4.40 ± 0.28 | 4.74 ± 0.30 | 7.72 ± 3.27 |

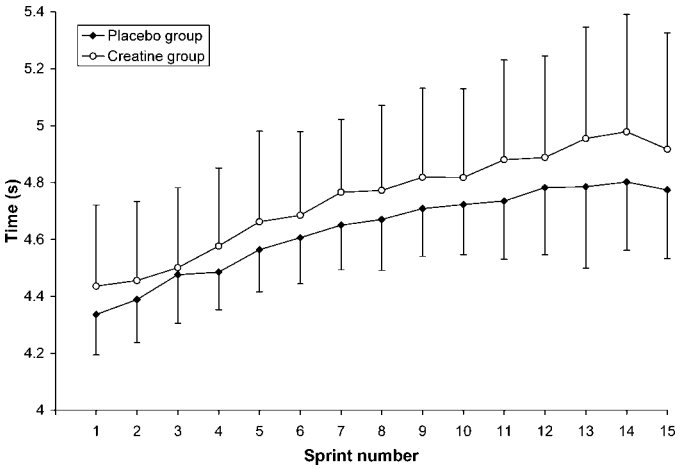


**FIGURE 1.** Presupplementation multiple sprint performance times (15 × 30 m; repeated at 35-second intervals). Values are means; bars are *SD*.

### Statistical Analyses

All statistical analyses were conducted using SPSS for Windows (SPSS Inc., Chicago, IL). Measures of centrality and spread are presented as mean ± *SD*. The effects of creatine supplementation on the various indices of multiple sprint performance were determined using 1-way analysis of covariance (ANCOVA). Change scores were the dependent variables within each model, with group, pretest score, and their interaction as predictors. Between-group differences in posttest blood-lactate concentrations were evaluated from unpaired *t*-tests. The above analyses provided 95% confidence limits for all measures.

## RESULTS

After adjusting for pretest scores, creatine supplementation resulted in a 0.7-kg increase in body mass (95% likely range: 0.02 to 1.3 kg), and a 0.4% reduction in body fat (95% likely range: −0.2 to 0.9%) relative to placebo. Baseline ($T_2$) data are presented in Table 2, with between-group differences in multiple sprint performance, pre- ($T_2$) and post- ($T_3$) supplementation, presented in Figures 1 and 2, respectively. Relative to placebo, creatine supplementation resulted in a 1.0% increase in fatigue (95% likely range: −0.6 to 2.6%), a 0.01-second reduction in fastest sprint time (95% likely range: −0.04 to 0.05 seconds), and a 0.04-second increase in mean sprint time (95% likely range: −0.02 to 0.10 seconds). Posttest ($T_3$)

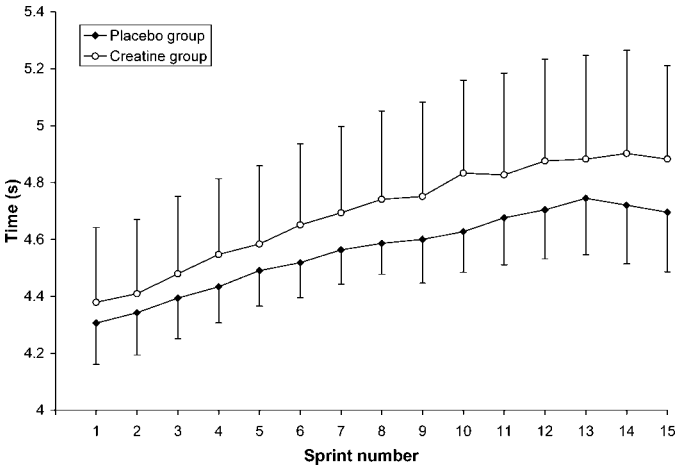


**FIGURE 2.** Postsupplementation multiple sprint performance times (15 × 30 m; repeated at 35-second intervals). Values are means; bars are *SD*.

blood-lactate concentrations in the creatine and placebo groups were 13.0 ± 2.3 mmol·L$^{-1}$ and 12.2 ± 2.7 mmol·L$^{-1}$, respectively (mean difference: 0.8 mmol·L$^{-1}$; 95% likely range: −0.8 to 2.3 mmol·L$^{-1}$).

## DISCUSSION

The objective of this study was to examine the effects of short-term creatine supplementation on multiple sprint exercise typical of that often experienced in many field sports. The major findings were that creatine supplementation had no significant effect on measures of fastest time, mean time, fatigue, or posttest blood lactate concentration. Although muscle PCr was not measured directly, the increase in body mass shown by the creatine group was consistent with that reported in previous research (10). Moreover, the lack of any corresponding increase in body fat conforms to reports that most of the increase in body mass after short-term creatine supplementation is because of an increase in fluid retention (25, 50). Although it is possible that the increase in body mass may have counteracted any ergogenic effect of creatine supplementation, this seems unlikely given the relatively small increase in body mass concerned and the fact that investigations into the influence of creatine supplementation on multiple sprint running (1, 2, 15, 34, 42, 43) display the same contradictions as those using non-weight-bearing protocols (5, 14, 27, 28, 30, 33, 51). Nevertheless, the precise effect of this magnitude of body mass gain on multiple sprint running performance requires further investigation.

The absence of any significant change in fastest sprint time corroborates previous research into the effects of creatine supplementation on single (≤10 second; 12, 14, 15, 39) and multiple (1, 2, 5, 15, 27, 33, 34, 43) sprint performance. Although there are some conflicting reports (9, 26, 42, 51), this finding is most likely because of the fact that with a normal resting store of approximately 80 mmol·kg·dm$^{-1}$ (8, 19) and a maximum degradation rate of around 9 mmol·kg·dm$^{-1}$·s$^{-1}$ (24), PCr availability is unlikely to be a limiting factor at the onset of a bout of multiple sprint work.

A number of investigations have reported reductions in fatigue during multiple sprint work following creatine supplementation (1, 3, 9, 26, 27, 34, 49). Although this effect is generally attributed to enhanced PCr recovery kinetics, several investigations have failed to observe any improvement in postexercise PCr resynthesis as a result of creatine supplementation (15, 18, 29, 44, 47). Moreover, of those that have, only Lemon et al. (30) and Yquel et al. (49) reported an improvement within the first minute of recovery. As such, the results of this investigation and many others have failed to observe any improved ability to maintain multiple sprint performance following creatine supplementation (5, 14, 15, 30, 33, 43, 51). Low sample sizes combined with the relatively large coefficient of variation associated with measures of fatigue during multiple sprint work (20) may account for many of the disparities between results of previous investigations.

The idea of accelerated PCr recovery kinetics following creatine supplementation has been suggested to account for the reduction in posttest acidosis observed in some investigations (3, 27, 49). In effect, an enhanced availability of PCr in each sprint could increase hydrogen ion buffering via PCr hydrolysis and/or reduce anaerobic glycolytic flux. However, the results of this study and most previous investigations into multiple sprint work report either no effect (1, 5, 9, 14, 28, 34, 43) or an increase (42) in posttest acidosis as a result of creatine supplementation, regardless of the effect on performance.

## PRACTICAL APPLICATIONS

Despite a number of contrasting reports, creatine monohydrate has rapidly increased in popularity as an ergogenic aid for sport, with worldwide sales reaching approximately 2.5 million kg in 1999 (46). Although much of this growth is most likely because of the promotion of more favorable research findings, the results of this study suggest that, in terms of the effects of creatine supplementation on multiple sprint running performance, the expectations of many athletes are unlikely to be realized.

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