Low Dose Creatine Supplementation Enhances Sprint Phase of 400 Meters Swimming Performance

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This study demonstrated the effect of low dose creatine supplement (10 g. per day) on the sprinting time in the last 50 meters of 400 meters swimming competition, as well as the effect on exertion. Nineteen swimmers in the experimental group received creatine monohydrate 5 g with orange solution 15 g, twice per day for 7 days and nineteen swimmers in the control group received the same quantity of orange solution. The results showed that the swimmers who received creatine supplement lessened the sprinting time in the last 50 meters of 400 meters swimming competition than the control group. ($p<0.05$) The results of Wingate test (anaerobic power, anaerobic capacity and fatigue index) compared between pre and post supplementation. There was significant difference at $p<0.05$ in the control group from training effect whereas there was significant difference at $p<0.000$ from training effect and creatine supplement in the experiment group. Therefore, the creatine supplement in amateur swimmers in the present study enhanced the physical performance up to the maximum capacity.

Keywords : *Creatine supplement, Sprint, Swimming, Wingate*

J Med Assoc Thai 2004; 87 (Suppl 2): S228-32
e-Journal: *http://www.medassocthai.org/journal*

Creatine is a naturally occurring amino acid found in abundance in skeletal muscle. Its phosphorylated form transfers phosphate to adenosine diphosphate (ADP) to maintain high levels of adenosine triphosphate (ATP) and thus provides energy for muscle activity [1]. Mixed muscle phosphocreatine availability could be increased as part of an overall increase in the total creatine (free creatine + phosphocreatine) concentration after ingestion of creatine monohydrate by humans [2]. The present study showed that 5 g creatine taken 4-6 times/day for several consecutive days increased the total creatine concentration of human skeletal muscle by an average of 25 mmol/kg dry mass, some 30% of which occurred in the phosphorylated form as phosphocreatine. The authors suggested that creatine supplementation might improve exercise performance in humans. Ingestion of creatine at a rate of 20 g/day for 5 days was found to improve performance during repeated bouts of maximal, isokinetic knee-extensor exercise, decreasing fatigue by up to 6%. No change in performance was found in a placebo group [3]. These results were confirmed by several experimental models involving cycling and running [4-7].

Creatine is currently legal and its use by athletes is not construed as doping [8]. The normal daily requirement from either exogenous or endogenous sources is approximately 2 g to replace catabolized creatine, which is excreted from the kidneys as creatinine [2]. Using 20 to 30 g of creatine monohydrate/day for 2 days, Harris et al [2] reported a significant increase in the total creatine of the quadriceps femoris muscle, indicating that 20 to 40% of the increase in total creatine was accounted for by phosphocreatine. They noted that muscle uptake of oral creatine supplementation was greatest in the first 2-day supplementation period, with smaller increases in subsequent days. Hultman et al [9] employed several strategies, including a rapid protocol involving 6 days of creatine supplementation at a rate of 20 g/day, and a slower protocol with supplementation for 28 days at a rate of 2 g/day to demonstrate the maintenance of elevated total creatine using creatine supplement at a rate of 2 g/day. Studies by Green et al [10,11] have shown that combining the creatine with a simple carbohydrate, such as glucose; will

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increase creatine transport into the muscle even in subjects with near normal levels of muscle creatine, possibly via an insulin-mediated effect. The solution consisted of 5 g of creatine and about 90 g of simple carbohydrate, consumed 4 times per day. The creatine-carbohydrate supplement increased total creatine by 60% and phosphocreatine by 100% compared to the creatine supplement alone [11].

Ergogenic effect of creatine supplement on swimming performance is disputable. Two studies examined the effect of creatine supplementation (20 g/day for 5 days) on 100-m swim time in 32 elite male and female swimmers in a double-blind manner. Creatine supplementation failed to improve 100-m sprint swim time [12-14]. In a similar study of male and female junior competitive swimmers, Grindstaff et al [13] concluded that their study provided some evidence of the efficacy of creatine in enhancing repetitive swim sprint performance but supplementation had no effect on cumulative 50-m or 100-m swim time. Peyrebrune, et al [15]. suggested that ingesting 9 g creatine per day for 5 days can improve swimming performance in elite competitors during repeated sprints, but appears to have no effect on a single 50 yard sprint. These experimental protocols typically employed high power output efforts for a short period at the beginning of the bout to demonstrate the beneficial effect of creatine supplement. On the contrary the present study was designed to investigate the positive effect of low dose creatine (10 g/day for 7 days) on lessening the last 50 meter sprint time in a 400 meter swimming competition.

Material and Method

The study was a double-blind, placebo controlled design. Subjects were randomly assigned to the supplement group or control group.

Subjects

Thirty eight males between ages 16-23 year (mean age, 20.07 years) were recruited for the present study. Subjects had to be physically active (minimum of three swimming periods weekly on a regular basis) and have been swimming for at least one year. Subjects were excluded from participation if they had routinely used medication that might alter the study outcome or received an injury that could affect the study outcome.

Subjects were fully informed of the requirements of their participation and of the potential benefits and risks. All subjects were required to sign an informed consent form. All procedures were reviewed and approved by the Ethics Committee of the Faculty of Medicine, Chulalongkorn University.

Experimental procedure

Thirty eight subjects (n = 19 in the control group and in the supplement group) completed all preliminary screening and testing procedures before starting the supplement. The supplement group received 10 g of creatine monohydrate supplement powder and 30 g of orange juice powder per day for 7 days. The control group received only 30 g of orange juice powder per day for 7 days.

Testing

One day before and after the supplement period, the following tests were conducted: 1) body weight; 2) anaerobic power, anaerobic capacity and fatigue index were measured using a 30-s Wingate arm cycle ergometer test; 3) last 50 meter sprint time in 400 meter swimming competition.

Anaerobic power and anaerobic capacity and fatigue index

Subjects performed a 30-s maximal cycle exercise test on Sport Cycle ergometer. Subjects were permitted a general warmup period that included walking, cycling and stretching. At the start of the test, the resistance was increased to 0.047 multiplied by body mass (kg). Subjects pedaled as rapidly as possible with verbal encouragement from the researchers. Anaerobic power and anaerobic-capacity and fatigue index were calculated with the Wingate software program. Anaerobic power was calculated as the quotient of peak power and body weight, and anaerobic capacity was calculated as the quotient of mean power and body weight. The fatigue index was expressed as a percentage: (highest power output - lowest power/highest power) x 100.

Measurement of total swimming time and last 50 meter sprint time

The total swimming time and the last 50 meter sprint time in the 400 meter competitive swimming for each subject was the average time from three referee time keepers.

Statistical analysis

Data were analyzed with student paired t-test with repeated measures on time. All statistical analyses were performed using SPSS 11.0 for Windows.

Results

All subjects completed the study protocol without adverse effects from either treatment or the testing procedures. The body weight was significantly increased after creatine loading period (7 days) for the supplement group (0.73 ± 1.11 kg; p = 0.010), whereas there was no significant body weight gain in the control group (0.40 ± 1.14 kg; p = 0.144) (Fig. 1).

Anaerobic power and capacity and fatigue index as assessed with a 30-s Wingate cycle test (Table 1)

Anaerobic capacity improved over a low dose creatine supplement period (10 g per day for 7 day). The anaerobic capacity in the control group was significantly increased from the baseline ($p < 0.05$). Furthermore, the larger increase ($p < 0.001$) of anaerobic capacity was also noticed. A slight change was observed for the anaerobic power output in the control group (p = 0.055), whereas a significant change was observed in the creatine loading group. Fatigue index did not change significantly over the low dose creatine loading, although there was a trend toward an increase (p = 0.058) compared with the control group (p = 0.986).

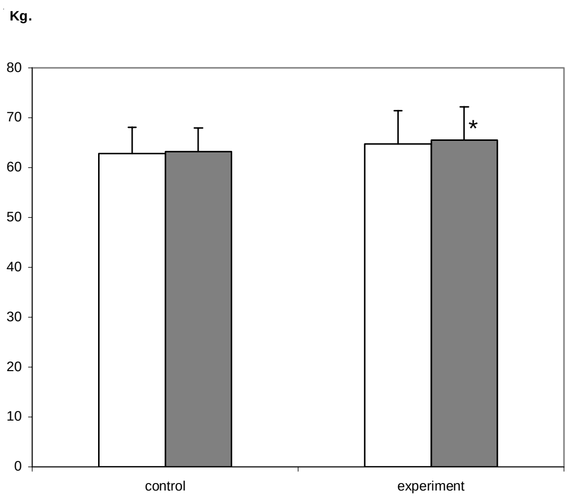

Fig. 1 Effect of creatine supplementation on body weight. *P < 0.05, pre-loading versus post-loading (open bars for pre - loading, closed bar for post-loading)

Total swimming time and the last 50 meter sprint time in the 400 swimming competition

Nineteen subjects in the supplement group performed a better record of both the total swimming time (p = 0.005) and the last 50 meter sprint time (p = 0.001) during the 400 meter competitive swimming than the subjects in the control group (p = 0.044 for the total swimming time and p = 0.081 for the last 50 meter sprint time). Data are shown in Table 2.

Discussion

Ingestion of creatine monohydrate at a dose of 20 g per day for 5-6 days was shown to increase the human muscle total creatine concentration by about 25 mmol/kg dry mass, some 30% of this in phosphorylated form as phosphocreatine [1,16]. Theoretically, an increase in total creatine stores may provide an ergogenic effect during sprint exercise by enhancing the rate of ATP synthesis during contraction and by improving the rate of phosphocreatine resynthesis during recovery, which may be beneficial for repeated sprint activity. The increased rate of phosphocreatine resynthesis [17] or buffered energy depletion during exercise bouts [18] have been shown to improve exercise adaptations may be due to an increased anaerobic work capacity.

Many studies have shown improvements in mean power (anaerobic capacity) and peak power (anaerobic power) and fatigue index during a single bout of cycle ergometer sprinting [19] or during multiple bouts [20]. Seven days creatine supplement with the

Table 1. Effect of creatine supplement on the anaerobic power, anaerobic capacity and fatigue index*

	Pre-loading	Post-loading	P - value
Anaerobic power output (W/kg)			
Control group (n = 19)	6.22 ± 0.52	6.44 ± 0.45	0.055
Supplement group (n = 19)	6.11 ± 0.59	6.73 ± 0.61	0.000***
Anaerobic capacity (W/kg)			
Control group (n = 19)	5.15 ± 0.46	5.41 ± 0.51	0.041**
Supplement group (n = 19)	4.96 ± 0.42	5.36 ± 0.44	0.000***
Fatigue index (%)			
Control group (n = 19)	37.94 ± 7.25	37.98 ± 10.74	0.986
Supplement group (n = 19)	40.42 ± 11.87	45.42 ± 9.35	0.058

* Data are mean ± standard deviation
** P < 0.05, pre-loading versus post-loading in control group
*** P < 0.001 , pre-loading versus post- loading in supplement group

Table 2. Effect of creatine supplement on swimming time*

	Pre-loading	Post-loading	P - value
400 meter swimming time			
Control group (n = 19)	416.07 ± 104.95	407.83 ± 96.80	0.044**
Supplement group (n = 19)	413.12 ± 107.73	395.89 ± 91.13	0.005***
Last 50 meter sprinting time			
Control group (n = 19)	49.23 ± 11.39	48.26 ± 11.00	0.081
Supplement group (n = 19)	47.91 ± 12.25	46.44 ± 11.65	0.001***

**Data are mean ± standard deviation.
**P < 0.05, pre-loading versus post-loading in control group
***P < 0.001 , pre-loading versus post- loading in supplement group

dose of 10 g per day in the present study demonstrated that anaerobic power and anaerobic capacity (as show in Table 1) was significantly increased in a 30-s arm cycling Wingate test. Although the effect of creatine supplement on fatigue index was not statistically different, it showed a trend of improving in the supplement group compared with the control group. The significant increase of anaerobic capacity work in the control group was due to the training effect ($p < 0.05$). However, the increase in anaerobic power and anaerobic capacity were much more significant because of the combining effect of training and creatine loading in the supplement group ($p < 0.001$).

The experimental evidence supporting an ergogenic effect for creatine supplement is somewhat mixed. Several studies have demonstrated an improved high-intensity exercise performance after creatine supplement [4,5,21], whereas several others have reported no beneficial effects [14, 22, 23]. Creatine supplement with the dose of 20 g per day for 5 days also failed to improve 100-m sprint swimming time and cumulative 50-m or 100-m swim time [12-14]. It is possible that creatine supplement presumably increased the rate of ATP resynthesis in human muscle, therefore, it should benefit the last sprinting in the competitive swimming. Furthermore, the authors intended to study the effect of creatine feeding on the last 50 meter sprint time in the 400 meter competitive swimming in order to avoid the confounder effect of take off techniques and difference in preparation time for take off. The result showed a decrease in the last 50 meter sprint time in the 400 meter competitive swimming in the supplement group.

Grindstaff et al [13] demonstrated in their study that 3% increase in competitive swimmers' body weight was a consequence of 5 days creatine supplementation for 20 g per day. The result in another study found that creatine supplement significantly increased net lean mass gains of 0.36 %/wk and strength gains of 1.09 %/wk [24]. Subjects received 10 g creatine per day for 7 days in the present study also showed significant increase in body weight.

In summary, low dose creatine supplementation at 10 g per day for 7 days increased the body weight which may be due to the increase in lean mass gain. It enhanced the anaerobic capacity and anaerobic power as well as improved the swimming performance in the last 50 meter sprint time in 400 meter competitive swimming in young amateur swimmers.

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ผลของการเสริมสารครีเอทีนปริมาณต่ำต่อการว่ายน้ำระยะสุดท้ายในการว่ายน้ำระยะ 400 เมตร

วิไล อโนมะศิริ, สมพล สงวนรังศิริกุล, พิศุทธิ์ สายจันทร์ดี

การศึกษานี้ แสดงถึงผลของการเสริมสารครีเอทีน ในปริมาณต่ำ (10 กรัม/วัน) ต่อระยะเวลาที่ใช้ในการเร่งความเร็วช่วงสุดท้าย (50 เมตร) ก่อนเข้าเส้นชัยของการแข่งขันว่ายน้ำระยะ 400 เมตร และเปรียบเทียบประสิทธิภาพของการออกกำลังกาย นักกีฬาว่ายน้ำชาย จำนวน 19 คน ในกลุ่มควบคุมได้รับการเสริมสารครีเอทีนจำนวน 5 กรัม ร่วมกับสารละลายน้ำส้มจำนวน 15 กรัม วันละ 2 ครั้ง นาน 7 วัน นักกีฬาว่ายน้ำชาย จำนวน 19 คนในกลุ่มควบคุมจะได้รับสารละลายน้ำส้มในปริมาณเท่ากัน ผลการทดลองสรุปว่า นักว่ายน้ำกลุ่มที่ได้รับการเสริมสารครีเอทีนใช้เวลาในการว่ายน้ำระยะ 50 เมตรสุดท้ายน้อยกว่านักว่ายน้ำกลุ่มที่ไม่ได้รับ อย่างมีนัยสำคัญทางสถิติ ($p<0.05$) และการทดสอบสมรรถภาพร่างกายโดยวิธีวินเกทค่าความสัมพันธ์ของกำลังงานที่ทำได้สูงสุดต่อมวลของร่างกาย และค่าความสัมพันธ์ของสมรรถภาพการใช้พลังงาน แบบไม่ใช้ออกซิเจนต่อมวลของร่างกาย ของกลุ่มควบคุม หลังจากได้รับสารละลายน้ำส้มดีกว่าก่อนได้รับ อย่างมีนัยสำคัญทางสถิติที่ $p < 0.05$ ซึ่งเป็นผลมาจากการฝึกซ้อม ส่วนกลุ่มทดลองมีความแตกต่างอย่างมีนัยสำคัญทางสถิติที่ $p < 0.000$ ซึ่งเป็นผลมาจากการฝึกซ้อมและการเสริมสารครีเอทีน การเสริมสารครีเอทีนในปริมาณต่ำ (10 กรัม/วัน) ในนักกีฬาว่ายน้ำสมัครเล่นมีผลต่อระยะเวลาในการแข่งขัน ว่ายน้ำ และเพิ่มประสิทธิภาพการออกกำลังกาย
