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Effects of creatine supplementation on body weight and anaerobic performance in Thai national wheelchair racing athletes

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Khaothin J, Mougnee P, Anomasiri W, Sanguanrungrsirikul S. Effects of creatine supplementation on body weight and anaerobic performance in Thai national wheelchair racing athletes. Chula Med J 2007 Mar; 51(3): 127 - 38

- Objective** : *The purposes of this study were to compare the effects of creatine supplementation and placebo on body weight and anaerobic performance in Thai national wheelchair racing athletes.*
- Participants** : *Twelve healthy wheelchair racing athletes, aged 23-30 years old, were participants in this study.*
- Design** : *Randomized, double-blind, placebo-controlled crossover-design study.*
- Method** : *The study protocol was a crossover design, which consisted of a 7-day treatment phase followed by a 21-day washout period, then after the second treatment phase. A typical short-term creatine supplementation protocol began with a loading dose of 20 g/day for 5 days. In group I, participants received 5 g Cr.H₂O powder + 15 g orange solution powder (creatine) during phase I of the study and 15 g orange solution powder (placebo) during phase II, whereas those in group II received converse treatment in a standard texture. During the 5-week study period, the subjects were required to take a series of 4 separate tests on their height, body weight and arm crank Wingate test. These tests were performed on day 1 and day 7 in both supplementation periods.*

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Results : *The results of this study showed that creatine supplementation showed no significant effect on body weight compared to placebo supplementation. There was no significant difference on anaerobic performances: peak power, anaerobic power, anaerobic capacity, fatigue rate and fatigue index. There was, however, a significant difference in mean power in post-creatine compared with post-placebo supplementation (P=0.04).*

Conclusion : *In conclusion, short-term creatine supplementation (20 g/d for 5 d) did not show any significant effect on body weight and anaerobic performance measured from arm crank Wingate test (except mean power) in Thai national wheelchair racing athletes.*

Keywords : *Short-term creatine supplementation, Anaerobic performance, Wheelchair athletes.*

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จักรพงษ์ ขาวถิ่น, ประทุม ม่วงมี, วิไล อโนมะศิริ, สมพล สงวนรังศิริกุล. ผลการเสริมสาร
ครีเอทีนต่อน้ำหนักตัว และสมรรถภาพแอนแอโรบิกในนักกีฬาวิลด์แชร์เรสซิ่งทีมชาติไทย.
จุฬาลงกรณ์เวชสาร 2550 มี.ค; 51(3): 127 - 38 .

- วัตถุประสงค์** : การวิจัยเชิงทดลองนี้มีวัตถุประสงค์เพื่อเปรียบเทียบผลการเสริมสาร
ครีเอทีน และสารหล่อลื่นที่มีผลต่อน้ำหนักตัว และสมรรถภาพแอนแอโรบิก
ในนักกีฬาวิลด์แชร์เรสซิ่งทีมชาติไทย
- กลุ่มตัวอย่าง** : นักกีฬาวิลด์แชร์เรสซิ่งที่มีสุขภาพดี จำนวน 12 ราย อายุระหว่าง 23-30 ปี
- รูปแบบการวิจัย** : รูปแบบของการวิจัยครั้งนี้เป็นการศึกษาแบบไขว้
- ระเบียบวิธีการวิจัย** : รูปแบบของการวิจัยครั้งนี้เป็นการศึกษาแบบไขว้แบ่งออกเป็น 2 ช่วง
การวิจัยในแต่ละช่วงประกอบด้วย การเสริมสารเป็นระยะเวลา 7 วันคั่นด้วย
ช่วงขับออกของสารเป็นระยะเวลา 21 วัน รูปแบบของการเสริมสารครีเอทีน
ช่วงสั้นประกอบด้วย การเสริมสารครีเอทีนปริมาณ 20 กรัมต่อวันเป็นระยะ
เวลาต่อเนื่อง 5 วัน กลุ่มตัวอย่างกลุ่มที่หนึ่งจะได้รับสารครีเอทีนในปริมาณ
ครึ่งละ 5 กรัมและผงละลายน้ำส้มปริมาณ 15 กรัมในช่วงแรกของการศึกษา
และได้รับสารหล่อลื่นผงละลายน้ำส้มปริมาณ 15 กรัมในช่วงที่สองของ
การศึกษา ส่วนกลุ่มที่สองจะได้รับสารที่ตรงกันข้ามกับกลุ่มที่หนึ่งในแต่ละ
ช่วงของการศึกษาทำการทดสอบสมรรถภาพต่าง ๆ ประกอบด้วย วัดสวนสูง
ซิ่งน้ำหนัก ประเมินสมรรถภาพแอนแอโรบิกของแขนด้วยวิธีวินเกต ทั้งหมด
4 ช่วง ของการศึกษาทั้งสิ้น 5 สัปดาห์ โดยทำการทดสอบในวันที่ 1 และ 7
ของการเสริมสารในทั้ง 2 ช่วงของการศึกษา
- ผลการศึกษา** : ผลการศึกษาพบว่า การเสริมสารครีเอทีนไม่มีความแตกต่างอย่างมีนัย
สำคัญทางสถิติต่อน้ำหนักตัว ในช่วงการเสริมสารครีเอทีนเปรียบเทียบกับ
สารหล่อลื่นไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติต่อสมรรถภาพ
แอนแอโรบิก ในกำลังสูงสุด กำลังแบบแอนแอโรบิก ปริมาณสมรรถภาพ
แบบแอนแอโรบิก อัตราความเมื่อยล้า ดัชนีความเมื่อยล้า อย่างไรก็ตามมี
ความแตกต่างอย่างมีนัยสำคัญทางสถิติในค่าเฉลี่ยกำลังเปรียบเทียบ
ระหว่างภายหลังการเสริมสารครีเอทีนและภายหลังการเสริมสารหล่อลื่น
($P = 0.04$)
- ผลสรุป** : จากผลการศึกษาสรุปว่าการเสริมสารครีเอทีนช่วงสั้น (20 กรัมต่อวัน เป็น
ระยะเวลา 5 วัน) ไม่มีความแตกต่างอย่างมีนัยสำคัญต่อน้ำหนักตัว และ
สมรรถภาพแอนแอโรบิกของแขนด้วยวิธีวินเกต (ยกเว้นมีความแตกต่าง
ของค่าเฉลี่ยกำลัง) ในนักกีฬาวิลด์แชร์เรสซิ่งทีมชาติไทย
- คำสำคัญ** : การเสริมสารครีเอทีนช่วงสั้น, สมรรถภาพแอนแอโรบิก, นักกีฬาวิลด์แชร์

Creatine is used in muscle cells to store energy for sprinting and explosive exercise. Athletes can increase the amount of creatine in the muscle by taking creatine supplements. Although some studies^(1, 2) reported no ergogenic effect, most studies⁽³⁻⁵⁾ indicate that creatine supplementation (e.g., 20 g per day for 5 to 7 days) increases sprint performance by 1-5 % and work performed in repeated sprints by up to 15 %. These ergogenic effects appear to be related to the extent of the uptake of creatine into the muscles.⁽⁴⁾ Creatine can be obtained by eating meat and fish products or it can come from supplementation powders. It is primarily made in 2 main forms, e.g., free and phosphocreatine forms. Approximately, 60 % of muscle creatine is phosphocreatine, which aids in the fast resynthesis of adenosine triphosphate (ATP) during short-term and high-intensity exercise. The involved mechanism is the transfer of a phosphate group from phosphocreatine to adenosine diphosphate (ADP) via creatine kinase to replenish ATP, which is consumed quickly during high-intensity exercise. Results of some studies showed that dietary supplementation of creatine were beneficial in improving strength, power, and recovery from high-intensity exercise in unimpaired person.⁽⁶⁻⁸⁾

However, studies on short-term (less than 2 weeks) exercises show no adverse event associated with creatine supplementation. Some studies indicate that short-term creatine supplementation increases total body mass by 0.7 to 1.6 kg and up to 3 kg more with longer use in matched control groups.^(10, 11)

Studies also demonstrated that creatine supplementation may promote gains in lean body mass during training but its mechanism is not clearly understood. The two prevailing theories are that creatine supplementation promotes either water

retention or protein synthesis. The only known side effect is the increased body weight. More research is needed to be done on individual differences in the response to creatine and its side effects.

Although most research studies of this supplementation have generally been limited to normal athletic population, creatine supplementation was also used in rehabilitated persons as well as those with physical disabilities. The aim of the researches was to explore the ergogenic effect of creatine during the recovery period. Creatine supplementation has been proved to increase muscle strength in patients with atrophic quadricep muscle.⁽¹²⁾ It is possible that reconditioned populations, particularly those with dietary intake of creatine may especially benefit more from creatine supplementation than athletes with physical disabilities.

Athletes with physical disabilities have decreased capacity of their upper extremities. In particular, athletes with physical disabilities have limited proficiency in require physical strength, power, and anaerobic performance. It is possible that de-conditioned populations, particularly those with diminished dietary intake of creatine, may especially benefit from a short-term creatine supplementation. This investigation seeks to determine the effects of short-term creatine supplementation on body weight and anaerobic performance in Thai national wheelchair racing athletes.

Materials and Methods

Participants

The participants were 12 healthy wheelchair racing athletes, and injury-free volunteer men from Thai national wheelchair athlete team. The participants were restrict-randomly divided into 2 treatments by block of four. The study protocol is a crossover design,

which consisted of 7 days treatment phase followed by 21 days washout period, then after the second treatment phase.

Data Collection

Design

This crossover design study was a double-blind, with random assignment of subjects into 2 treatment groups. The study protocol consisted of 2 treatment phases, each lasting for 7 days and separated by 21 days of washout period (Figure 1). A 3-week washout period was adequate to allow serum creatine levels to return to baseline.^(14,15)

In group I, participants received creatine during phase I of the study and placebo during phase II, whereas those in group II received converse treatment. Subjects in both groups were blinded as to which supplementation they were receiving.

Supplementation Protocol

A typical short-term creatine supplementation protocol begins with a loading dose of 20 g/day for 5 days. Participants were instructed to 5 g Cr.H₂O powder + 15 g. orange solution powder (creatine) or 15 g orange solution powder (placebo) of the respective supplementation with 250 ml water, 4 times a day (morning, lunch, evening, and late evening) on day 2-6 for both 7 days treatment periods.⁽¹³⁾

Testing Protocol

They were required to perform a total of 4 separate tests during a 5-week study period. These tests were performed on day 1 and day 7 in both supplementation periods. Participants were request to abstain from caffeine, nicotine, alcohol, and strenuous exercise for 12 hours before testing. The following tests were conducted: 1) body weight and height; 2) 30 s arm crank Wingate test.

Experimental Procedure

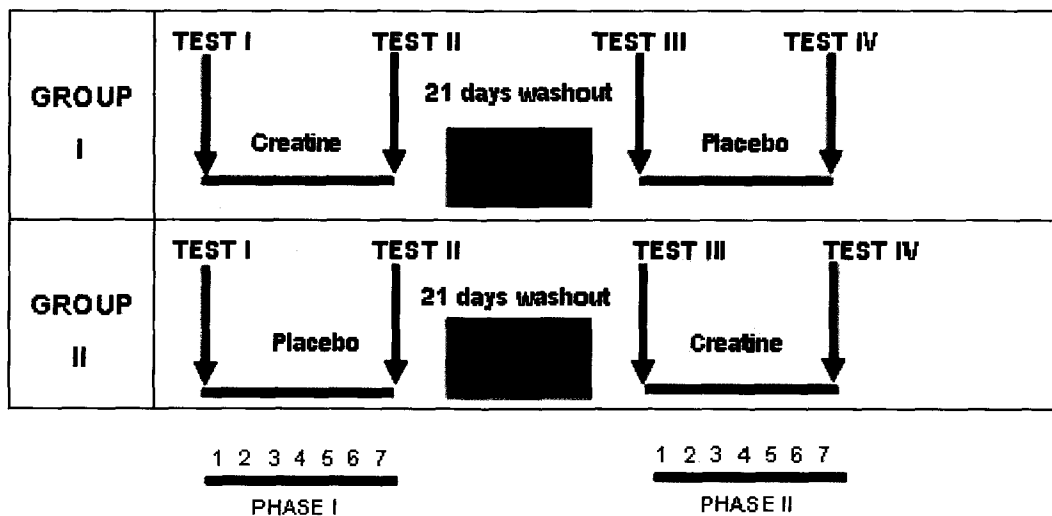


Figure 1. Experimental design.⁽¹³⁾

Body Weight and Height

Participants were weighed in shorts or swimming suit without shoes. Their body weight was measured to nearest 0.02 kg on digital platform scale (Yamamoto DP-6100 GP, Japan). The height was measured using a wall scale with subjects standing upright and arms hanging freely along the sides without shoes. The height was measured to the nearest 0.5 cm. The body mass index (BMI) was calculated by dividing weight (kg) with squared height (m^2).

Peak Power, Mean Power, Anaerobic Capacity, Anaerobic Power, Fatigue Rate and Fatigue Index

Anaerobic fitness was assessed using an adapted 30 s arm crank Wingate test. This maximal effort 30 s cycle arm crank ergometry test was developed at the Wingate Institute in Israel in the 1970's.⁽¹⁶⁾

According to the Lode Wingate protocol program, the most commonly used Wingate test length is 30 seconds. This is a time period for maximal efforts where the major fuel source is anaerobic. The Wingate Protocol typically consists of three parts:

1. The warm-up: cycling at a comfortable pace for a freely programmable number of minutes.
2. The Wingate test: "all-out" cycling for 30 seconds, while the braking force is set at its full intensity right from the start (default: 0.4 x body weight in Nm).
3. The recovery: once the Wingate test is completed, resistance is set for example to 100W (freely programmable); the subject keeps pedaling for as long as desired.

There are five indices that describe the person's performance in the Wingate test: Peak Power,

Mean Power, Anaerobic Power, Anaerobic capacity, Fatigue Rate and Fatigue Index.

Statistical Analysis

Data were analyzed according to recommended methods for a 2-period crossover design using SPSS program. These methods included analysis with *t*-test and applications of the *t*-test to assess for period effect and treatment period interaction. In all cases, the statistical significance was accepted at a *P* value of 0.05 or less.

Results

The aim of this research was to study the effects of creatine supplementation on body composition and anaerobic performance in Thai national wheelchair racing athletes. This study was approved by the Ethics Committee, Graduate School, Burapha University. Twelve healthy wheelchair racing athletes from Thai national wheelchair racing athletes were recruited to the study which consisted of 7 days treatment phase followed by 21 days of washout phase, and then after the second treatment phase.

Participant's Physical Characteristics

Twelve healthy wheelchair racing athletes from Thai national wheelchair racing athletes were participated in the study. Participants received either Cr supplementation ($n=8$) or placebo supplementation ($n=4$) in phase I, and received Cr supplementation ($n=4$) or placebo supplementation ($n=8$) in phase II. The physical characteristics of the Thai national wheelchair racing athletes are presented in Table 1.

Body Weight

Body weight was measured to the nearest 0.02 kg on digital platform scale (Yamamoto DP-6100

Table 1. Physical Characteristic of Thai National Wheelchair Athletes. (n = 12)

Variable	Mean ± SD.
Age (yr)	26.5 ± 3.39
Height (cm)	161.50 ± 8.85
Weight (kg)	52.93 ± 10.96
Body mass index (kg/ m ²)	20.26 ± 3.64

GP, Japan), there were no differences between creatine and placebo supplementation (Table 2). Statistically, there was no significant increase in body weight noted in the pre- and post-creatine supplementation (53.31 ± 5.99 to 53.65 ± 5.67 kg; *P* = 0.38); no change was observed in pre- and post-placebo supplement (53.32 ± 5.99 to 53.55 ± 5.66 kg; *P*=0.35).

Peak Power, Mean Power, Anaerobic Power, Anaerobic Capacity, Fatigue Rate, Fatigue Index, assessed with a 30 s Wingate Test

The anaerobic performances were recorded

on day 1 and 7 in both phases of the study. Peak power, anaerobic capacity and anaerobic capacity did not improve after creatine and placebo supplementation. There were no differences between groups for these variables (Table 3). Across the groups, the mean power was changed after creatine supplementation. A statistically significant increase in the mean power was noted in the post-creatine when compared to the post-placebo supplementation. Fatigue rate and fatigue index were not significantly changed over time, between groups, or timeXgroups interaction.

Table 2. Comparison of Body Weight (Kg) between Creatine and Placebo of Thai National Wheelchair Athletes.

Variable	Creatine (n = 12)	Placebo (n = 12)	<i>p</i> -value
Body weight (kg)			
Pre-Supplement	53.31 ± 5.99	53.32 ± 5.99	0.34
Post-Supplement	53.65 ± 5.67	53.55 ± 5.66	0.19

Note: Data are mean ± SD.

Table 3. Comparison of Peak Power, Mean Power, Anaerobic Power, Anaerobic Capacity, Fatigue Rate and Fatigue Index Between Creatine and Placebo of Thai National Wheelchair Athletes.

Variable	Creatine (n = 12)	Placebo (n = 12)	p-value
Peak Power (Watt)			
Pre-Supplement	367.42 ± 89.24	365.10 ± 86.05	0.33
Post-Supplement	376.55 ± 85.77	361.22 ± 84.76	0.28
Mean Power (Watt)			
Pre-Supplement	325.89 ± 75.24	324.88 ± 62.11	0.32
Post-Supplement	326.91 ± 76.53	320.02 ± 82.44	0.04*
Anaerobic power (W/kg)			
Pre-Supplement	6.94 ± 0.50	6.90 ± 0.48	0.35
Post-Supplement	6.89 ± 0.50	6.82 ± 0.44	0.41
Anaerobic capacity (W/kg)			
Pre-Supplement	6.16 ± 0.60	6.08 ± 0.65	0.38
Post-Supplement	6.17 ± 0.56	6.05 ± 0.71	0.06
Fatigue rate (W/Sec)			
Pre-Supplement	0.70 ± 0.23	0.70 ± 0.22	1.00
Post-Supplement	0.71 ± 0.24	0.69 ± 0.21	0.06
Fatigue index (%)			
Pre-Supplement	11.23 ± 5.44	11.87 ± 6.96	0.65
Post-Supplement	10.41 ± 5.48	11.69 ± 6.92	0.34

Note: Data are mean ± SD, * Significant differences between post creatine and post placebo supplementation.

Discussion

These studies examined the effects of short-term creatine monohydrate supplementation on body composition and anaerobic performance of wheelchair racing athletes under normal in-season training conditions. Twelve healthy wheelchair racing athletes from Thai national wheelchair racing athletes were participated in the study. All participants were diagnosed with three classes of poliomyelitis (polio) athletes, i.e., class T52 (n=1); class T53 (n=2); and

class T54 (n=9). A randomized block design was used to reduce initial group differences, an often overlooked procedure that increased chances of obtaining spurious results. Furthermore, the statistical analysis proved that there was neither period effect nor treatment period interaction in this design.

Body weight

Body weight increases have been observed as one of the constant side effects of creatine supplementation. ^(14,17) Poormans et al. (1997) ⁽¹⁸⁾

evaluated the adverse effects of creatine supplementation. When specifically examining the effect of creatine supplementation on body weight, it was noted that 70 % of published data showed an increase in total body weight. This increase varied between 1 to 2 kg. Although the majority of studies reported that creatine supplementation increased body weight and lean body mass, the mechanism in which creatine supplementation may gain in body weight and lean body mass was not entirely understood. Nevertheless, Kreider (1998)⁽⁴⁾ reviewed three prevailing theories. First, since gains in body weight (about 1 kg) can occur within 3 to 7 days, some suggest that the gains in body weight observed are simply due to greater water retention. In support of these contention initial studies, Hultman et al. (1996)⁽¹⁴⁾ reported that urine output declined during the first three days of creatine supplementation. Additionally, Kreider (1998)⁽⁴⁾ demonstrated that intracellular fluid volume increases during the first three days of creatine supplementation. Second, creatine supplementation may affect protein synthesis. This theory suggests that creatine stimulated gain in intracellular water may serve to increase osmotic pressure which in turn stimulated protein synthesis. Finally, some suggest that since creatine may allow an athlete to train harder, the enhanced training stimulus may promote greater muscle hypertrophy over time.

The present study showed the results of creatine supplementation on body weight of Thai national wheelchair racing athletes. No significant differences between creatine supplementation and placebo supplementation were observed in body weight. Indeed, in the present study body weight gain was observed in some but not all participants

supplemented with creatine for five consecutive days. Data of this study is in agreement with the results of some studies in that no significant effects were found on body weight and lean body mass following short-term creatine supplementation regimens.^(19,20)

The existing data suggested that short-term creatine supplementation (20 g/d for 5 d) had no effect on body weight in Thai national wheelchair racing athletes. Several factors possibly interplayed to determine the amount of creatine that is retained within the bodies of Thai national wheelchair racing athletes. Most of these factors are at baseline or pre-supplementation levels of creatine in individuals.⁽²¹⁾ Future differences in creatine levels and its uptake may arise from fiber composition, gender⁽²²⁾, and age.⁽²³⁾ Since all participants were poliomyelitis disability athletes (polio) with muscle atrophy in lower extremities, this might be the reason that no significant response to creatine supplementation was observed.

Peak Power, Mean Power, Anaerobic Power, Anaerobic Capacity, Fatigue Rate and Fatigue Index

The literatures indicated that muscle creatine concentration as a result of creatine supplementation likely significant improved performance during single and repeated bouts of maximal short-duration exercise. The available data indicate that it may be related to the stimulatory effect that creatine supplementation has on pre-exercise PCr availability, especially in fast-twitch muscle fibers.⁽⁷⁾ Theoretically, an increase in TCr stores may provide an ergogenic effect during a high intensity exercise by enhancing the rate of ATP synthesis during contraction and by improving the rate of PCr during recovery, which may be beneficial for high-intensity activity.⁽³⁾

This study investigated high intensity exercise performance after creatine supplementation in Thai national wheelchair racing athletes using 30 s arm crank Wingate test. No significant increase in peak power, anaerobic power, anaerobic capacity, fatigue rate and fatigue index was noted in the creatine supplementation and placebo supplementation. There was no significant difference between groups. A statistically significant increase in mean power was observed in the creatine group compared to the group of placebo supplementation ($P=0.04$). It is important to note that the mean power increased after creatine supplementation and there was a trend toward a greater decrease in fatigue index in creatine supplementation than in placebo supplementation. This contention is supported by the findings of other studies on improvements of mean power, total work completed, or fatigue index during a single bout of cycle ergometer sprinting.^(8,24) On the basis of some scientific literature, some athletes used creatine in attempts to improve their physical performance. It is suggested that individuals participating in sports require demonstration of a single or repeated bouts of maximal force generation might utilize creatine supplementation to artificially increase total creatine store in the muscles ($TCr = PCr + \text{free Cr}$). Theoretically, it is possible that athletes may benefit from creatine supplementation if the artificially increased TCr store enhances the processes of energy release and re-synthesis of ATP for high intensity exercise performance.

Conclusion

In conclusion, short-term creatine supplementation (20 g/d for 5 d) did not show significant

change on body weight, anaerobic performance measured from arm crank Wingate test (except mean power) in Thai national wheelchair racing athletes.

Acknowledgments

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