

JEPonline
Journal of Exercise Physiologyonline

Official Journal of The American
Society of Exercise Physiologists (ASEP)

ISSN 1097-9751

An International Electronic Journal
Volume 7 Number 6 December 2004

Body Composition

ORAL CREATINE SUPPLEMENTATION DOES NOT IMPROVE BODY COMPOSITION
IN RECREATIONALLY ACTIVE MEN DURING STRENGTH TRAINING

Ball SD¹, BOWEN-THWAITS J², SWAN PD²

¹Department of Nutritional Sciences, University of Missouri-Columbia

²Department of Exercise and Wellness, Arizona State University East

ABSTRACT

ORAL CREATINE SUPPLEMENTATION DOES NOT IMPROVE BODY COMPOSITION IN RECREATIONALLY ACTIVE MEN DURING STRENGTH TRAINING. **Ball SD, Bowen-Thwaits J, Swan PD. JEPonline.** 2004;7(6):9-15. The effects of oral creatine supplementation (CR) on body mass (BM), percent body fat (BF), fat mass (FM), and fat free mass (FFM) were examined. A double blind, crossover design compared 10 recreationally active college-aged men during a 10-week strength-training program. Five men were randomly assigned either 20 g creatine/day or 20 g/day of maltodextrine (PL) for five days, followed by a maintenance dose of 2 g/day for three weeks. Treatments were separated by a four-week washout period while training continued. Body composition was determined using whole body plethysmography (Bod Pod[®]). BM increased (1.52 ± 1.76 kg) ($P=0.028$) following CR compared to PL. FFM increased ($P<0.05$) in both CR (1.93 ± 2.61 kg) and PL (2.24 ± 2.10 kg) whereas FM and BF decreased ($P<0.018$) following PL but not CR (FM - 2.60 ± 2.37 kg; BF - 3.22 ± 2.88 %). In conclusion, CR significantly increased BM, without lowering BF and did not increase FFM greater than strength training alone.

Key Words: Fat loss, Body density, Body mass gain

INTRODUCTION

Athletes and other competitive fitness enthusiasts are continually trying various nutritional supplements to increase their muscle mass and/or decrease their body fat and improve performance. Creatine is one such dietary “muscle building” supplement that has become one of the most popular nutritional ergogenic aids among recreational and competitive athletes. Previous research has shown that creatine supplementation can increase total muscle creatine stores (2,16,19) thereby improving performance by delaying fatigue, increasing work production, increasing lean tissue and improving body composition (3,7,9,15).

In terms of body composition changes, many studies have reported that the recommended dose of five grams of creatine four to six times a day for five days results in an increase in body mass (BM) of 0.6 to 1.1 kg

(3,4,7,16,20,22). When training is extended for up to 12-weeks BM increases range from 0.6 - 5.2 kg (3,4,7,16,18,20,22,23,24). Most of these gains are attributed to increased fat free mass (FFM), without significant reductions in fat mass (FM) or percent body fat (BF). In fact, reports that BF does not decrease with creatine supplementation may indicate that FM may actually increase in proportion to reported gains in FFM (4,7,10,16,19,22). Thus, weight lifters who increase body mass with creatine supplementation may actually be maintaining and/or gaining body fat as well as building muscle.

The purpose of this study was to quantify relative and absolute changes in body composition with creatine supplementation concurrent with resistance training in healthy, recreationally active men. By implementing a pre-post crossover design, this study evaluated differences between treatment groups (creatine vs. placebo), while controlling the influence of trial order (exercise intensity differences). It was hypothesized that creatine supplementation would increase BM but that there would be no differences in BF, FFM, or FM between trials.

METHODS

Subjects

Apparently healthy males (n=10, age 18-40) were screened for cardiovascular risk factors via questionnaire as determined by the American College of Sports Medicine (1). Subject criteria for this study excluded men on vegetarian, high-protein/low-carbohydrate or energy restrictive diets, those with previous use of creatine supplements or current use of any other ergogenic aids, and required moderate to no alcohol consumption (no more than two servings per week). Subjects were recreationally active, yet not well trained.

Design

A double blind, crossover design was used for a total of 10 weeks of continuous weight training. Subjects were randomly assigned to a CR (creatine monohydrate, X-Rated, Hi-Health, 20 g/d for 4 days followed by 2 g/d for 17 days), or placebo (PL) trial for three weeks of resistance training. Following the first three weeks of supplementation, subjects underwent a four-week washout period (8,12,17,21). Treatments were then alternated for the final three weeks. PL was in the form of maltodextrine of the same color and texture as the creatine supplement. Both supplements were in identical bottles and were measured, prepared and distributed by a separate administrator. Subjects were asked to maintain their normal dietary and daily activity habits during the 10-week training period. Food intakes were recorded (via telephone interview) for two days each week, and were analyzed using the Genesis R & D software (version 6.01, 1997, Esha Research, Salem, OR), with a registered dietitian in charge of dietary evaluation. Total energy expenditure and net energy balance were approximated and monitored throughout the training. Subjects were required to keep a log of all weight training activity, as directed by the administrators of the study.

Strength Training

Strength training consisted of one hour/day, three days/week using standard protocol emphasizing hypertrophy and strength phases, as reported by Volek et al. (23). Pre-training strength values were determined by one-repetition max testing (1 RM) including two trials on both the leg press and bench press, separated by several days to ensure accurate baseline levels. All one-repetition maximum (1 RM) testing was conducted on the same equipment with identical subject/equipment positioning overseen by one trained investigator, with a test-retest reliability of $r=0.993$ and $r=0.987$ for leg press and bench press respectively. The resistance was progressively increased in incremental loads until failure (23). All 1 RM values were determined in three to five attempts. Strength testing was repeated at the end of three, seven and ten weeks. Body mass and height were determined to the nearest 0.1 kg and 1 cm, respectively. Skin-folds were taken at seven sites using Harpenden calipers (Lafayette, Instruments) according to the recommendations of Jackson and Pollack (13). All folds were taken on the right side of the body three times for consistency. Skin-folds were taken by one trained technician, with a test-retest reliability of $r = 0.96$ for the sum of seven skin-folds.

Body Composition

Body composition was determined using whole body air displacement plethysmography (Bod Pod[®]). Body volume was determined and converted into body density and then percent fat values using the Siri equation (11). All measurements were taken according to the recommended procedures for Bod Pod[®] testing (5). Subjects were fasted for at least 4 hours and asked to refrain from exercise for 12 hours prior to testing. Subjects were directed to wear a lycra swim cap and tight fitting lycra/spandex bike shorts, or swimming briefs, for each trial and all were instructed to void their bladder and bowels upon arrival. The initial measured lung volume on the Bod Pod was entered for each subsequent test to ensure reliability. Bod Pod[®] testing was performed by one technician, with a test-retest reliability of $r = 0.989$ in a subset of ten men and women.

Statistical Analyses

Values are expressed as means \pm standard deviation (SD). Analysis of variance for repeated measures compared differences in body composition changes between groups before and after supplementation. Changes in measures were analyzed between treatment groups (treatment effect) as well as within group differences (trial order effects). P values < 0.05 were considered significant.

RESULTS

There was no significant trial order effect ($P > 0.20$) for any of the body composition variable measured. Initial physical characteristics before training were similar between subjects (Table 1). Table 1 indicates that following training, there was a significant ($P = 0.023$) increase in BM following creatine supplementation. Both treatments showed significant gains in FFM, however only PL group lost a significant ($P = 0.008$) amount of FM and showed a significant ($P = 0.006$) decrease in BF. The ratio of FM/FFM significantly decreased ($P = 0.003$) during the PL trial. Additionally, 1 RM leg press values increased significantly ($P < 0.05$) following PL treatment, whereas both 1 RM chest press and 1 RM leg press values increased significantly following CR supplementation. The amount of change in each body composition variable by treatment group is presented in Figure 1. No treatment effect (i.e., difference between CR and PL) was seen in the increase in FFM. However, BF was significantly ($P < 0.03$) reduced as a result of a significant decrease in FM following placebo. BM was significantly increased for the creatine group compared to placebo.

Table 1. Mean body composition values between trials.

Variable	Creatine (N=10)	Creatine (N=10)	Placebo (N=10)	Placebo (N=10)
	Pre	Post	Pre	Post
Body Mass (kg)	73.6 \pm 7.3	75.1 \pm 7.9*	75.2 \pm 7.9	74.9 \pm 7.6
Fat Mass (kg)	10.7 \pm 4.4	10.2 \pm 3.6	12.1 \pm 4.7	9.5 \pm 3.2‡
Fat Free Mass (kg)	63.0 \pm 3.5	65.0 \pm 5.8*	63.2 \pm 4.4	65.4 \pm 5.8**
Body Fat Percent (%)	14.0 \pm 4.8	13.3 \pm 3.9	15.7 \pm 4.9	12.4 \pm 3.7†
FM/FFM Ratio	0.17 \pm 0.06	0.16 \pm 0.05	0.19 \pm 0.07	0.14 \pm 0.05**
Sum of Skin-fold (mm)	53.7 \pm 16.5	53.8 \pm 16.7	56.5 \pm 18.9	56.8 \pm 19.7
1 RM Bench Press (kg)	87.0 \pm 13.0	91.0 \pm 10.0§	90.0 \pm 13.0	92.0 \pm 13.0
1 RM Leg Press (kg)	280.0 \pm 61.0	313.0 \pm 71.0§	300.0 \pm 58.0	314.0 \pm 58.0**

Values are Mean \pm SD. FM: Fat Mass; FFM: Fat Free Mass; 1RM: One repetition maximum

* $P < 0.05$, Pre-Creatine vs. Post-Creatine; † $P < 0.05$, Pre-Placebo vs. Post-Placebo; ‡ $P < 0.02$, Placebo vs. Creatine

** $P < 0.01$, Pre-lacebo vs. Post-Placebo; § $P < 0.01$, Pre-Creatine vs. Post-Creatine

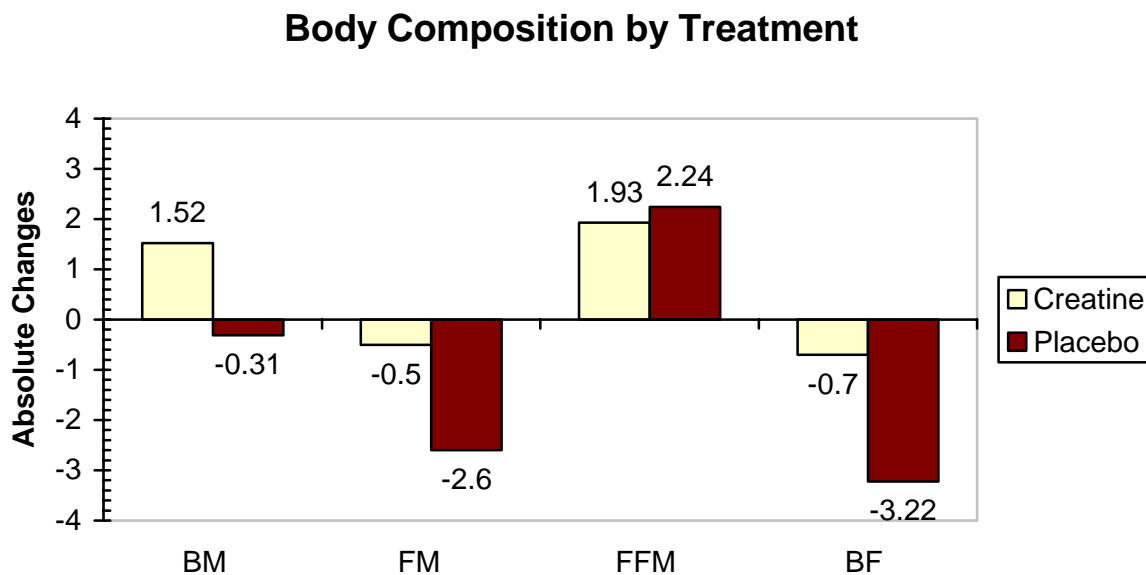


Figure 1. Body composition changes by treatment. Values are given as absolute changes between treatment trials for Body Mass, BM (kg); Fat Mass, FM (kg); Fat Free Mass, FFM (kg); and Percent Body Fat, BF (%).

DISCUSSION

This study supports earlier studies that CR supplementation increases BM with resistance training and indicates that CR supplementation does not enhance BF loss in recreationally active men in the short term (several weeks). Previous research has demonstrated net BM gains of 0.6 to 5.2 kg following one to twelve weeks of CR supplementation and FFM increases from 0.6 kg to 4.3 kg (7,16,18,20,22,23,24). However, these studies did not report significant loss in FM or changes in BF during CR supplementation concurrent with an increase in BM. For example, Volek et al. (23) found that following 12-weeks of resistance training, men that supplemented with 25 grams of creatine/day for one week followed by a maintenance dose of 5 g/day significantly increased BM 5.2 kg. An increase of only 3.0 kg was found for PL. They further reported a significant difference in the change in FFM using hydrostatic weighing, 4.3 kg vs. 2.1 kg over the 12-week training period for CR and PL respectively. However, they reported no differences at any time for either training group or between treatment groups for BF and FM. Similarly, although Mihic et al. (18) observed a significant difference between CR and PL groups for both FFM and BM, measured by dual-energy x-ray absorptiometry (DXA) scans, there was no significant change in BF between groups. In other words, it is assumed in both these studies that both FM and FFM increased proportionally to account for the rise in BM. Furthermore, Becque et al. (4) found an increase of 2.0 kg and 1.6 kg for BM and FFM respectively in the CR group, but reported total FM and BF to be unchanged, as measured by hydrostatic weighing techniques. Thus, despite increases in BM, other studies have not described a consistent reduction in FM and BF with creatine supplementation.

Results from this study suggest that CR supplementation does not improve body composition, (i.e. the ratio of FM/FFM). In fact, the data indicate that supplemental creatine ingestion may possibly inhibit the amount of fat used as a fuel that normally accompanies a vigorous weight training program, and thus may actually inhibit overall body fat loss. The mechanism responsible for inhibiting body fat reduction with creatine supplementation is not discernible from this study. However, previous results demonstrate that individuals taking creatine may reduce their ability to lose FM in response to exercise training (14). The results from this

study suggest that creatine loading may inhibit the normal fat loss that occurs in healthy active men implementing a strength-training program. Moreover, recent research noted a trend for the resting respiratory exchange ratio (RER), which is an indication of substrate utilization, to be higher following creatine supplementation, which suggests a potential mechanism for the impaired fat loss. Further research is needed to identify shifts in fuel utilization while weight training with creatine supplementation.

In the current study the sum of skin-fold measures tended to not change over time ($P > 0.85$) regardless of treatment. This would suggest that skin-fold measures are less sensitive than body density values for indicating overall body fat changes with exercise in this population. Because the Bod Pod[®] is a measure of whole-body density, it is not dependent on the assumptions regarding subcutaneous fat stores that limit the interpretation of skin-fold values. Thus a change in total body density without a change in sum of skin-folds may indicate a preferential loss of internal (visceral) vs. subcutaneous fat resulting from the training program. Because visceral fat is an important component of health, if it is shown that visceral fat loss is inhibited as a result of CR supplementation, then men who supplement with CR may actually be jeopardizing their health. Other investigators have shown decreases in abdominal vs. subcutaneous fat in men following vigorous training (6) confirming that training does not effect body fat distribution uniformly. Further investigations using accurate measures of body fat distribution such as computed tomography need to be done to identify the influence of CR supplementation on specific fat loss.

CONCLUSIONS

The implications of this study are important for coaches, weight lifters and/or any exercise professionals interested in the effects of CR on body composition. Increases in body size, body mass, and strength, are goals for many athletes and weight lifters. Additionally, these weight lifters expect to lose body fat with vigorous exercise training. Results from this study indicate that although CR supplementation seems to be effective for increasing body mass, it did not increase FFM greater than strength training alone. These results suggest that creatine loading may inhibit normal fat loss that occurs in healthy, active men implementing a strength-training program in the short term. In conclusion, the results from this study support the hypothesis that CR increases BM in recreationally active men performing resistance training. However, the results also demonstrate that individuals on CR may reduce their ability to lose FM in response to exercise training.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Dr. Wayne Phillips for his expertise and help with the weight lifting protocol. Also we are grateful to the 10 volunteers of this study for their dedication and enthusiasm throughout this study

Address for correspondence: Stephen Ball, Ph.D., Department of Nutritional Sciences, University of Missouri 315 Gwynn Hall. Columbia, MO 65211. Phone: 573-882-2334; Email: ballsd@missouri.edu

REFERENCES

1. American College of Sports Medicine. **ACSM's Guidelines for Exercise Testing and Prescription**, 6th ed. Philadelphia, PA: Lippincott, Williams & Wilkins, 2000.
2. American College of Sports Medicine roundtable. The physiological and health effects of oral creatine supplementation. *Med Sci Sports Exerc* 2000;2(3):706-717.
3. Balsom PD, Ekblom B, Soderlund K, Sjodin B and Hultman E. Creatine supplementation and dynamic high-intensity intermittent exercise. *Scand J Med Sci Sports* 1993;3:143-149.

4. Becque MD, Lochmann JD and Melrose DR. Effects of oral creatine supplementation on muscular strength and body composition. *Med Sci Sports Exerc* 2000;32(3):654-658.
5. Dempster P and Aitkens S. A new air displacement method for the determination of human body composition. *Med Sci Sports Exerc* 1995;27(12):1692-1697.
6. Despres JP, Bouchard C and Tremblay A. Effects of aerobic training on fat distribution in male subjects. *Med Sci Sports Exerc* 1985;17(1):113-118.
7. Earnest CP, Snell PG, Rodriguiz R, Almada AL and Mitchell TL. The effect of creatine monohydrate ingestion on anaerobic power indices, muscular strength and body composition. *Acta Physiol Scand* 1995;153:207-209.
8. Febbraio MA, Flanagan TR, Snow RJ, Zhao S and Carey MF. Effect of creatine supplementation on intramuscular TCr, metabolism and performance during intermittent, supramaximal exercise in humans. *Acta Physiol Scand* 1995;155:387-395.
9. Greenhaff PL, Bodin K, Harris RC, Hultman E, Jones DA, McIntyre DB, Soderlund K and Turner DL. The influence of oral creatine supplementation on muscle phosphocreatine resynthesis following intense contraction in man. *J Physiol* 1993;467:75P.
10. Grindstaff PD, Kreider R, Bishop R, Wilson M, Wood L, Alexander C and Almada A. Effects of creatine supplementation on repetitive sprint performance and body composition in competitive swimmers. *Int J Sport Nut* 1997;7:330-346.
11. Heyward VH and Stolarczyk LM. **Applied Body Composition Assessment**. Champaign, IL: Human Kinetics, 1996.
12. Hultman E, Soderlund K, Timmons JA, Cederblad G and Greenhaff PL. Muscle creatine loading in men. *J Appl Physiol* 1996;81:232-237.
13. Jackson AS and Pollack ML. Practical assessment of body composition. *The Phys and Sports Med* 1985; 13(5): 76-89.
14. Huso ME, Hampl J, Johnston C and Swan PD. Creatine supplementation influences substrate utilization at rest. *J Appl Physiol* 2002;93:2018-2022.
15. Kreider RB, Klesges R, Harmon K, Grindstaff P, Ramsey L, Bullen D, Wood L, Li Y and Almada A. Effects of ingesting supplements designed to promote lean tissue accretion on body composition during resistance training. *Int J Sport Nu* 1996;6:234-246.
16. Kreider RB, Ferreira M, Wilson M, Grindstaff P, Plisk S, Reinardy J, Cantler E and Almada AL. Effects of creatine supplementation on body composition, strength, and sprint performance. *Med Sci Sports Exerc* 1998;30(1):73-82.
17. McKenna MJ, Morton J, Selig SE and Snow RJ. Creatine supplementation increases muscle total creatine but not maximal intermittent exercise performance. *J Appl Physiol* 1999;87(6):2244-2252.
18. Mihic S, MacDonald JR, McKenzie S and Tarnopolsky MA. Acute creatine loading increases fat-free mass, but does not affect blood pressure, plasma creatinine, or CK activity in men and women. *Med Sci Sports Exerc* 2000;32(2):291-296.
19. Noonan D, Berg K, Latin RW, Wagner JC and Reimers K. Effects of varying dosages of oral creatine relative to fat free body mass on strength and body composition. *J Strength and Cond Res* 1998;12(2):104-108.
20. Snow RJ, McKenna MJ, Selig SE, Kemp J, Stathis CG and Zhao S. Effect of creatine supplementation on sprint exercise performance and muscle metabolism. *J Appl Physiol* 1998;84:1667-1673.
21. Vandenberghe K, Van Hecke P, Van Leemputte M, Vanstapel F and Hespel P. Phosphocreatine resynthesis is not affected by creatine loading. *Med Sci Sports Exerc* 1999;31(2):236-242.
22. Vandenberghe K, Goris M, Van Hecke P, Van Leemputte M, Vangerven L and Hespel P. Long-term creatine intake is beneficial to muscle performance during resistance training. *J Appl Physiol* 1997;83(6):2055-2063.
23. Volek JS, Duncan ND, Mazzetti SA, Staron RS, Putukian M, Gomez AL, Pearson DR, Fink WJ and Kraemer WJ. Performance and muscle fiber adaptations to creatine supplementation and heavy resistance training. *Med Sci Sports Exerc* 1999;31(8):1147-1156.

24. Volek JS, Kraemer WJ, Bush JA, Boetes M, Incledon T, Clark KL and Lynch JM. Creatine supplementation enhances muscular performance during high-intensity resistance exercise. *J Am Diet Assoc* 1997;97(7):765-770.