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Effects of creatine supplementation on body mass and muscle girths in bodybuilders

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Summary

Study aim: To find out whether a 6-week creatine supplementation would significantly augment body mass and muscle circumferences in male bodybuilders.
Material and methods: A group of 14 male bodybuilders aged 16 – 29 years were randomly divided into two groups: experimental (E) and control (C), 7 subjects each. Group E received creatine monohydrate, Group C – *placebo*, 10 g daily for 6 weeks without saturation phase. The experimental design was a double-blind one. All subjects were on strictly controlled diet, the daily intakes amounting to 2.3 – 2.8 g of protein, 1.0 – 1.2 g of fat and 5 – 6 g/kg body mass of carbohydrate, and 3200 – 4000 kcal. All subjects trained 3 days a week, each session lasting 120 min, in the 'Power, Rep-Range, Shock' mode. Chest, waist, arm, forearm, thigh and calf girths were measured in the relaxed and contracted states, together with body mass, before and after the study.
Results: Significant, training-induced changes were noted in almost all body circumferences studied in both groups and muscle states, those in the chest, biceps and thigh girths being the most pronounced ones and significantly ($p<0.05$) greater in the experimental than in control group in the contracted muscle state. In the relaxed state the between-group differences were significant for the chest and thigh girths. The increments in body mass were significantly ($p<0.01$) higher in the experimental than in control group (4.3 ± 1.3 and 2.1 ± 0.7 kg, respectively).
Conclusions: The observed changes may have been brought about by creatine administration.

Key words: Training – Bodybuilding – Creatine – Somatic features

Introduction

The principal objective of bodybuilding is to attain a desired body build [3,9,23], those who practice such a training being approached subjectively which is rare in sports [10,11]. The way to achieve that objective consists of well designed resistance training, appropriate diet including supplementation and a rational recovery [11,16]; the final effect, i.e. perfect body build, is being assessed by many criteria, based mainly on well shaped musculature reflected by adequate muscle circumferences and body mass [8,15,19,22].

Apart from properly designed training loads, dietary supplements are an important component of bodybuilding [12,20,21], the legally most widely used substance for the last two decades being creatine. Administration of creatine augments the resynthesis of phosphocreatine in the muscles, especially following high-intensity exertions, which contributes to an improved work capacity and endurance, strength and muscle mass [2,6,7,13].

Beneficial effects of creatine administration were observed in diverse exertions; Balsom *et al*. [1] reported an increased power output in repeated cycle ergometer exercises (10×6 s) separated by 30-s intermissions following creatine intake (20 g daily for 6 days). Kreider *et al*. [9] applied 17.5 g of creatine daily for 28 days and noted increased work outputs in the first 5 out of 12 exertions lasting 6 s each and separated by 30-s intermissions. Even as short a supplementation as 4 days, 25 g of creatine daily, significantly improved swimming time in 3 series of exercises - 10×50 m with one-minute intermissions, and 8×100 m or 15×100 m with 2-min intermissions; a prolonged administration of creatine (5 g daily for 2 months) brought about no further improvement [11]. Also in endurance-related sports, e.g. repeated runs (4×300 m with 3-min intermissions or 4×1000 m with 4-min intermissions) an improvement was noted following a 6-day administration of creatine for 6 days [2].

The use of creatine supplementation markedly expanded in recent years, especially in the cardiological

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pharmacology; creatine has been considered an inducer of protein synthesis (increased generation of actin and myosin in cell cultures) apart from its role as an energy transducer in the cells [9,11]. Nevertheless, the reports on the effects of creatine administration in various sports have not been sufficiently concordant so as to draw conclusions with respect to bodybuilding. Thus, the aim of this study was to find out whether a 6-week creatine supplementation would significantly augment body mass and muscle circumferences in male bodybuilders.

Material and Methods

A group of 14 male subjects, aged 16 – 29 years, members of a recreational sport club, volunteered to participate in the study and submitted their written consents. The study was approved by the local Committee of Ethics. They had 3 training sessions a week, 120 min each, in the afternoons. The subjects were randomly assigned into two groups: experimental (E), receiving creatine supplementation, and control (C).

Throughout the 6-week study, both groups were subjected to the same training protocol of the 'Power (1), Rep-Range (2), Shock (3)' mode [18], every element dominating in weekly microcycles. The microcycles differed in the kinds of exercise (eccentric, concentric, mixed), intensities and intermission durations, as well as in the so-called stick point isometric elements [9,22]. Thus, the three-week unit was repeated twice. Training loads were computed ex post from individual, detailed records.

Subjects from the experimental group were given micronised (250 mesh) creatine monohydrate (Vitalmax, Poland) without carbohydrates, those from the control group receiving placebo. The experiment was conducted in the double-blind mode. The following supplementation schedule was used: on training days (Monday, Wednesday, Friday), 5 g of creatine (or placebo) was ingested 30 min before the training session and 5 g immediately after the session; on other days, 5 g was ingested in the morning, in fasting state, and 5 g in the evening, between meals. No saturation phase was used.

The protein-rich diet was strictly individually controlled by an experienced dietician. The daily calorie intake amounted to 3200 – 4000 kcal, that of protein – 2.3 – 2.8 g, fat – 1.0 – 1.2 g, carbohydrate – 5 – 6 g/kg body mass. The subjects rigorously followed the recommendations and consumed no extra products and used no other supplementation.

The following girths were measured in the relaxed and maximally contracted states [14]: chest, waist, arm (biceps), forearm, thigh and calf, all before ('Pre') and after the study period ('Post') using a metal tape with an accuracy of 0.1 cm. Body mass was determined in the morning, in the preprandial state, without clothing, with an accuracy of 0.1 kg. Chest girth was measured between the *mesosternale* and *thelio*n points, that of the thigh and the calf at the respective highest thickness, the lower limb straight and both legs evenly loaded, that of the waist at the level of the navel, that of the arm and of forearm at the respective mid-length, the extremity straight along the body. The Post-Pre differences (increments) of all measurements were computed.

The significances of the Post-Pre differences were assessed using the Student's *t*-test for dependent data and the between-group differences by applying that test for independent data. The level of $p \leq 0.05$ was considered significant.

Results

The basic data (age, training experience, body height and body mass – initial and the study-induced increment) of both groups of bodybuilders are presented in Table 1, the results of anthropometric measurements in Table 2 and percent changes in measurements, related to the initial (Pre) ones – in Fig. 1.

Table 1. Mean values (±SD and ranges) of basic features of male bodybuilders

Variable	Group	Experimental (n = 7)	Control (n = 7)
Age (years)		21.0 ± 4.1 (17 – 29)	19.6 ± 4.0 (16 – 25)
Body height (cm)		181.9 ± 7.3 (174 – 194)	180.9 ± 5.2 (171 – 186)
Body mass (kg)	Pre	88.9 ± 12.4 (64 – 102)	87.9 ± 9.3 (77 – 103)
	Increment	4.3 ± 1.3 (2 – 6)*** ^{oo}	2.1 ± 0.7 (1 – 3) ***
Training experience (years)		3.1 ± 1.6 (1.5 – 6)	2.7 ± 2.2 (1 – 7)

Legend: Significances of increments – * $p<0.05$; ** $p<0.01$; *** $p<0.001$; ^{oo} Significantly ($p<0.01$) higher from the increment in the control group

Table 2. Mean values (±SD) of anthropometric measurements in the relaxed and contracted states, before and after a 6-week study and respective increments in male bodybuilders

Muscle status	Relaxed		Contracted	
Measurement	Pre	Increment	Pre	Increment
Experimental group (n = 7)				
Chest	113.7 ± 10.6	2.1 ± 0.7*** °°	120.3 ± 9.6	4.4 ± 0.7*** °°°
Waist	84.4 ± 5.7	0.9 ± 1.3	82.7 ± 5.3	1.0 ± 0.6**
Biceps	39.5 ± 4.5	1.0 ± 0.3***	42.4 ± 4.1	1.9 ± 0.4*** °
Thigh	61.9 ± 5.5	1.7 ± 1.0** °	63.9 ± 5.2	2.6 ± 1.0*** °°
Calf	39.1 ± 4.0	0.5 ± 0.4*	40.0 ± 3.5	1.1 ± 0.5***
Forearm	35.5 ± 3.7	0.6 ± 0.4*	37.1 ± 3.8	1.1 ± 0.5**
Control group (n = 7)				
Chest	113.7 ± 10.6	1.2 ± 0.4***	120.3 ± 9.6	2.0 ± 0.9***
Waist	84.4 ± 5.7	1.5 ± 0.8**	82.7 ± 5.3	0.6 ± 0.7
Biceps	39.5 ± 4.5	0.7 ± 0.4**	42.4 ± 4.1	1.3 ± 0.5***
Thigh	61.9 ± 5.5	0.7 ± 0.4**	63.9 ± 5.2	1.0 ± 0.3***
Calf	39.1 ± 4.0	0.2 ± 0.3	40.0 ± 3.5	0.6 ± 0.6*
Forearm	35.5 ± 3.7	0.4 ± 0.4*	37.1 ± 3.8	0.9 ± 0.6**

Legend. Significances of increments: * p<0.05; ** p<0.01; *** p<0.001; Significantly higher from the respective value in the control group: ° p<0.05; °° p<0.01; °°° p<0.001

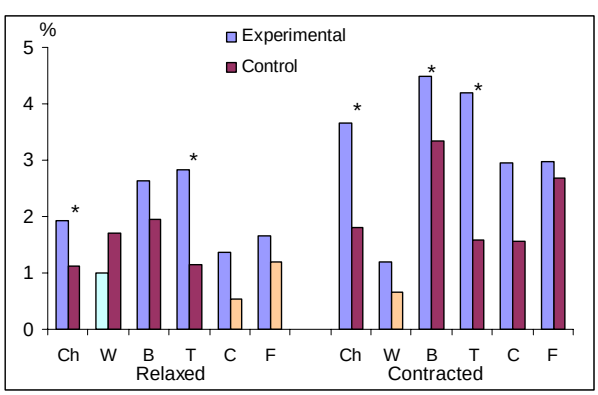

Fig. 1. Percent changes in body and muscle girths

Legend: Ch – Chest; W – Waist; B – Biceps; T – Thigh; C – Calf; F – Forearm; The changes represented by lighter-colour bars are non-significant; * Significant (p<0.05) between-group difference

Significant training-induced changes in all studied body circumferences were found in both groups in the relaxed and in contracted states except waist girth in the experimental (relaxed) and control (contracted) groups, and calf and forearm girths (relaxed) in the control group. The most pronounced relative (percent) changes were found in case of the biceps, thigh and chest girths in both states; these were significantly (p<0.05) greater in the experimental group (contracted state) than in the control one while in the relaxed state the between-group differences were significant for the chest and thigh girths only (Fig. 1). Besides, body mass significantly (p<0.001) increased in both groups, the relative increment being twice as high in the experimental as in the control group (4.8 and 2.4%, p<0.01; cf. Table 1).

Discussion

The 6-week training of bodybuilders brought about significant increases in body mass; in the experimental group under creatine supplementation, those increases were twice as high as in control subjects. Although the increases in body mass could have been attributed to a higher muscle hydration, the fact that subjects from both groups performed the same training is indicative of creatine as the causal factor. This view is supported by other reports [1,4,21] and own studies [11] on larger groups of subjects.

The mechanism of the creatine-induced increase in the chest girth is not clear. An increase in muscle hydration may be suspected but water content had not been determined. In the thigh muscles, and especially in the *quadriceps*, white fibres prevail and their content in the *vastus lateralis* muscle exceeds 80% [10,11,15,22,23]. These fibres more easily undergo hypertrophy than the red ones and, therefore, are faster and more efficacious [11,15,22,23] and the same is true for the *triceps*. This may explain the predominance of the training- and creatine-induced increases of arm and thigh girths in contrast to e.g. forearm or calf girths in which the content of red fibres is high.

As follows from the subjective, yet highly competent criteria of refereeing in bodybuilding competitions, those who underwent creatine supplementation were higher rated than the not supplemented ones. The impression of a 'qualitative" improvement of body shape is due to a reduced skin pad which brings out the muscle outlay apart from a lack of aerobic training and staying on a diet-induced positive energy balance. This is suggestive of applying creatine supplementation for the purpose of reducing body fat content, which has not been frequent in the literature [11]. The available reports point to a wide range of creatine supplementation – from short, maximal exertions, to prolonged ones of low intensity [5,6,10,17, 21]. Since the results are often equivocal, studies on creatine supplementation ought to be conducted on large groups and for long periods.

Summing up, the 6-week oral administration of creatine (10 g daily) to bodybuilders trained in the 'Power, Rep-Range, Shock' mode, brought about significantly greater increases in body mass and some body circumferences compared with the control group, both in the relaxed and contracted muscle states. This, combined with the higher scoring of creatine-supplemented subjects compared with the control ones points to the possibility of using creatine as a body fat-reducing agent.

References

1. Balsom P.D., B.Ekblom, K.Soderlund, B.Sjodin, E.Hultman (1993) Creatine supplementation and dynamic high intensity intermittent exercise. *Scand.J.Med.Sci.Sports* 3:143-149.
2. Harris R.G., M.Viru, P.L.Greenhaff, E.Hultman (1993) The effect of oral creatine supplementation on running performance during maximal short-term exercise in man. *J.Physiol.* 467:74P.
3. Heyward V.H., W.M.Sandoval, B.V.Colville (1989) Antropometric, body composition and nutritional profiles of bodybuilders during training. *J.Appl.Sports Sci.Res.* 3:22-29.
4. Hultman E., K.Soderlund, J.A.Timmons, G.Cederblad (2006) Muscle creatine loading in men. *J.Appl.Pysiol.* 81:232-237.
5. Hunter A. (1928) Monographs on Biochemistry: Creatine and Creatinine. Longmans, Green and Co., London.
6. Ingwall J.S. (1976) Creatine and the control of muscle-specific protein synthesis in cardiac and skeletal muscle. *Circ. Res.* 38:115-123.
7. Jones R. (1997) Kreatyna kreatynie nierówna. *Medycyna Sportowa* 3:21-24.
8. Katch V.L., F.J.Katch, H.Moffat, M.Gittleson (1980) Muscular development and lean body weight in bodybuilders and weight lifters. *Med. Sci.Sports Exerc.* 12:340-344.
9. Kreider R.B., M.Ferreira, M.Wilson, P.Grindstaff, S.Pilsk, J.Reinardy, E.Cantler, A.L.Almada (1998) Effects of creatine supplementation on body composition, strenghth and sprint performance. *Med.Sci.Sports Exerc.* 30:73-82.
10. Kruszewski M. (2007) Metody treningu i podstawy żywienia w sportach siłowych. Monografie COS Warszawa.
11. Kruszewski M. (2009) Effectiveness of muscular development and nutritional supplementation techniques in the aspect of motor potential and body composition changes in training participants. Studia i Monografie, AWF Warszawa.
12. Kruszewski M. (2005) Podnoszenie ciężarów i kulturystyka. Monografie COS, Warszawa.
13. Kruszewski M., B.Wit, K.Buśko, G.Kępa (2000) Effect of powerlifting training supplemented by creatine on sport results and body components.In: C.P.Lee (ed.) Proc.2nd Intern. Conf. Weightlifting and Strength Training. Ipoh, Malaysia, p. 103.
14. MacDougall J.D., H.A.Wenger, H.J.Green. (1998) Fizyologicheskoye testirovanye sportsmena vysokovo klassa. Olimpiyskaya Literatura, Kyiv, Ukraine.
15. McComas A.J. (1998) Skeletal Muscle Form and Function. Human Kinetics, Champaign, Ill.
16. Olek R. (1999) Co wiemy o kreatynie w końcu XX wieku? *Medycyna Sportowa* 11(100):24-31.
17. Ostberg K., K.Soderlund (1993) Kreatin. *Skidskytte* 5: 16-17.
18. Prevost M.C., A.G.Nelson, G.S.Morris (1997) Creatine supplementation enhances intermittent work performance. *Res.Q.Exerc.Sport* 68:233-240.
19. Sale D.G. (1992) Neural Adaptation to Strength Training. Strength and Power in Sport. Blackwell Sci. Publ., Oxford, pp. 249-265.
20. Smulski W.M., W.D.Monogarow, M.M.Bułatowa (1996) Pitanye w sisteme podgotovki sportsmenov. Olimpiyskaya Literatura, Kyiv, Ukraine.
21. Thorensen E., J.McMillan, K.Guion, B.Joyner (1998) The effect of creatine supplementation on repeated sprint performance. Conference NSCA, J.Strength Condit.Res. 4(12):277.
22. Trzaskoma Z., Ł.Trzaskoma (2001) Kompleksowe zwiększanie siły mięśniowej sportowców. Monografie COS, Warszawa.
23. Weider J. [1993] Bodybuilding System. Comes, Warszawa.

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