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Effect of Creatine Supplementation in Cyclist Performance and Body Composition

Juliano Elias Farah and Maria Gisele Dos Santos*

Parana Federal University, Brazil

***Corresponding Author:** Maria Gisele Dos Santos, Parana Federal University, Brazil.

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Abstract

Objective: The goal of this study was to analyze the effects of oral creatine monohydrate supplementation (CR), both separately and combined with the use of maltodextrine (MD) in the performance and body composition of elite cyclists.

Methods: The sample population was composed by twelve male subjects, of which five belonged to a group that consumed only creatine (G1: 20g de CR/day) for five days, two to a group that supplemented their diets with both creatine and maltodextrine (G2: 20g de CR more 40g de MD/day) during the same period and five to a control group (G3). The analysis of body composition was done by measuring body circumferences e fragmentation of body components according FERNANDES FILHO (2003) and HEYWARD STOLARCZYCK (2000). Performance was evaluated through a Wingate anaerobic muscle power test (*Wingate Test Cefise*).

Results: Test results indicated an increase in body weight in both groups, the largest occurring in G2 (0.8, +/- 25%). Body fat (kg) increased in subjects of both groups, being 19.82 +/- 5.94% for G1 and 11.47% +/- 65.59% for G2. Maximum muscle power increased 5.19% +/-57.78% in G1, but G2 experienced a decrease of 0.59 +/- 37.51% in that category after supplementation.

Conclusion: A 5-day period of constant creatine supplementation caused changes in both performance and body composition for G1 and G2, with increases in muscle power (G1) and body weight (G1 and G2), as well as increases in body fat for all subjects enrolled into the study.

Keywords: Supplementation; Creatine; Performance

Introduction

The search for better results leads athletes and physical activity practitioners to find effective and reliable means that may be able to optimize their performances and body composition patterns. Improvements in the performance of athletes can be achieved through appropriate nutritional habits [1], as well as excellent control of the intensities and rest periods during the exercises, achieved with an adequate dosage of the training methods [2].

Constantly, records and performance standards are broken and surpassed by better prepared and increasingly specialized individuals in the activity they practice, and possibly using some type of ergogenic resource to accomplish their deeds. Any type of substance, process or procedure that can, or is perceived to be capable of improving physical performance, including pharmacological agents, nutritional, physiological, psychological and mechanical components, is considered an ergogenic resource [1,3].

One of the components of the training variables that can cause great impact on the desired results is the nutritional component. A diet that contains adequate amounts of macronutrients (carbohydrates, proteins and fats) and micronutrients (vitamins and minerals) is essential for satisfactory results. However, it is not always possible for the individual to eat properly, eating a quantity of nutrients that are compatible with the metabolic demand of the activities they practice; therefore, it is necessary to resort to dietary supplements, contemplating the nutritional deficit found in the diet. In Brazil, there is currently a great use of supplements, which are used both for ergogenic and aesthetic purposes [4]. One of the most has become popular among athletes is creatine [5], in its form monohydrate, it has become one of the most widely used and researched supplements worldwide, at all times [6].

The use of creatine can be effective in maintaining high energy levels (ATP) during intense physical activities [7], and its supplementation is more efficient in exercises where muscle work specificity depends on the ATP-CP energy system (phosphocreatine or alanine anaerobic). It is believed that the amount of creatine phosphate (PCr) stored in muscle can be a limiting factor for physical performance in high intensity and short duration exercises. Thus, it is suggested that the increase in total creatine (CrT) and PCr muscle reserves induced by creatine supplementation may increase the availability of PCr and, consequently, accelerate the resynthesis rate of ATP during intermittent (repetitive) anaerobic exercises), favoring the improvement of physical performance in this type of exercise [8].

Thus, strength and muscular power exercises benefit from creatine supplementation [3], and short-duration and high-intensity activities are likely to improve performance [4].

The way creatine is administered can be performed from protocols of short duration (5-7 days) and long duration (over 15 days). Numerous studies have examined the effects of a brief period of supplementation on exercise performance [5]. Usually used doses are composed of 20-30 g/day (or 0.3 g/kg of body weight per day) distributed over 24 hours in portions of 5-7g, dissolved in some fluid for better absorption [9-11]. Combinations between protocols can also be performed, such as an initial period of overload (20-30 g/day of creatine for 5-7 days) followed by a longer maintenance time (2-5 g/day of creatine for 28 days or more) [11]. Results such as: (a) increase in the maximum capacity to develop muscular strength; (b) increased work performance during repetitive exercise series; (c) time reductions of single sprints and consecutive sprints; (d) improvement of muscular power levels; (e) increasing the number of repetitions in strength exercises; can be observed in both short and long term protocols [5,11-17], where supplemented subjects are submitted to physical tests, obtaining different results regarding performance and body composition.

Several researchers have conducted studies on creatine supplementation with maltodextrin, and found that through this combination, it promotes a greater retention of creatine in the muscle. One of the explanations is that the increase of the insulin concentrations stimulates the retention of creatine in the muscle [18-20].

Bicycle sprints are a type of physical activity that may benefit from creatine supplementation [6], and oral intake may promote gains in body mass and lean mass along with training [21]. Therefore, this study aims to analyze the effects of oral supplementation with creatine monohydrate, alone and concomitantly with the ingestion of maltodextrin (carbohydrate), on the performance and body composition of cyclists, using as means the Wingate anaerobic test for performance analysis and skinfolds and body circumferences to verify body composition.

Methods

This research is characterized as double blind, and the cyclists who participated in this study were previously informed of the type of experiment that would participate and formalized their written consents in that regard. The protocol and consent forms were previously approved by the Ethics Committee of the Federal University of Paraná.

The sample consisted of 15 randomly trained male cyclists, 25 to 30 years of age, five being part of the creatine group (G1), five of the creatine + maltodextrin group (G2) and five of the control group (G3). Subjects had a mean age of 26.57 7.09 years, body weight (BW) of 65.55 ± 5.05 kg. As a result, three cyclists did not attend the re-evaluation after the supplementation period. So the G2 got two cyclists.

Group G1 as G2 received supplementation of 20g/day of creatine for 5 consecutive days, the compound was divided into 4 doses of 5g each. G2 received in addition to creatine, 40g/day of maltodextrin, divided into 4 doses of 10g that were added to creatine doses. Both supplements were in the form of powder, duly weighed on a scale with accuracy of 0.01 g and separated into properly sealed plastic paper.

The anthropometric procedures described below were performed by the same evaluator before and after the supplementation period. The variables body weight (BW), stature (EST), body circumferences (WC) and bone diameters (OD) were collected following the procedures described by FERNANDES FILHO22. Eight skinfolds (DC) were measured: pectoral, abdomine, supra-iliac, axillary-middle, subscapular, triceps, mid-thigh and calf, following the procedures described by HEYWARD and STOLARCZYK [23].

Maximum anaerobic power test was applied through the Wingate test to quantify muscle power before and after supplementation. Data analysis was performed using the WINGATE

TEST software (Cefise). The procedures for applying the test were adopted according to FERNANDES FILHO (22) followed by some methodological modifications described below:

- o Heating: 3min, pedaling in low intensity, intercalating with small cycles (4-6s) of fast pedaling;
- o Acceleration period (10s);
- o Maximum acceleration (3s);
- o Test: pedaling 30s at maximum speed and force, with total work load (load index: 7.5% of PC ± 100g);
- o Back to calm: 1-2 min pedaling slowly with a light load (adapted from FERNANDES FILHO [22].

To analyze the results, descriptive statistics were used through relative and absolute comparisons between the pre- and post-test.

Results

Body weight (PC)

Body weight (PC) did not show significant increases in the supplemented groups, but the creatine + maltodextrin (G2) group had a higher increase in PC than the group that only took creatine (G1), and the control group did not presented changes in body weight (Table 1).

	G1 (n = 5)			G2 (n = 2)			G3 (n = 5)		
	PRE	POST	DIF%	PRE	POS	DIF%	PRE	POS	DIF%
Body weight	65,55	63,38	0,59	71,90	72,48	0,80	66,00	66,00	0,00
Right arm. rel	27,78	27,78	0,00	30,40	30,75	1,15	28,00	28,00	0,00
left arm rel	27,76	27,82	0,22	30,15	30,50	1,16	27,90	27,90	0,00
right arm cont	30,36	31,12	2,50	32,70	33,20	1,53	30,20	30,20	0,00
left arm cont	30,26	30,62	1,19	32,55	32,55	0,00	31,50	31,50	0,00
Right thigh	51,08	51,32	0,47	55,70	55,75	0,09	50,20	50,20	0,00
thigh left	51,48	51,32	0,31	55,65	56,10	0,81	51,00	51,00	0,00
right leg	34,54	34,32	0,64	36,05	36,55	1,39	35,00	35,00	0,00
Left leg	33,70	33,66	0,12	35,90	35,85	0,14	33,20	33,20	0,00

Table 1: Comparison of body weight and body circumference.

Right Arm. rel: relaxed right arm; left arm rel: left arm relaxed; right arm cont: right arm contracted; Left Arm Cont: Left Arm Contracted; Right Thigh: Right Thigh; Thigh Left: Left Thigh; Right Leg: Right Leg; Left Leg: Left leg. DIF%: Percentage Difference between pre and Post Test Samples.

Body Circumference (WC)

However, the circumferences of the contracted arms (G1) and of the relaxed arms and right leg (G2) were those that had the highest increases after the period of supplementation (> 1%).

Body composition

Table 2 shows the relative differences in body composition of the following components: body fat, muscle weight, bone weight and residual weight. Both groups had an increase in the sum of skinfolds as well as in the amount of body fat. The weight of lean body mass (MCM) remained practically the same, with a reduction in G1 (-34g) and an increase in G2 (+ 7g), and the control group did not present changes in the results. Muscle weight declined in both groups. The bone mass (bone weight) was not subject to change, and residual weight had a small increase in G1 (+ 8g) and G2 (+14) groups.

Maximum Anaerobic Power Test: Wingate;

In the Wingate test, the load index used was the same for all individuals (7.5% kg body weight ± 100g), as a result, we have the load expressed in Kp (kilopound) differently for each athlete tested. The results obtained are expressed in Table 3, as well as the other variables analyzed in the test.

The load used to perform the test was considerably higher in G2, due to the fact that these individuals had a higher body weight than G1, in detriment to these values, we can observe that G1 obtained a relatively large increase in power (+36, 43 watts), evidenced in the post-test, and the same pattern of improvement cannot be observed in the G2 post-test, which showed a yield decrease (-5.37 watts).

	G1 (n = 5)			G2 (n = 2)			G3 (n = 5)		
Body Components	**PRE**	**POST**	DIF%	**PRE**	**POS**	**DIF %**	**PRE**	**POST**	**DIF%**
Sum DC (mm)	42,16	48,90	15,99	49,70	53,80	8,25	44,50	44,50	0,00
Fats	5,65	6,74	19,38	5,94	6,57	10,65	5,20	5,20	0,00
MCM	94,35	93,26	1,16	94,06	93,43	0,67	94,20	94,20	0,00
Muscle weight	57,91	56,89	1,77	57,18	56,65	0,93	57,80	57,80	0,00
Bone weight	12,34	12,27	0,58	12,78	12,68	0,79	12,30	12,30	0,00
Residual weight	24,10	24,10	0,00	24,10	24,10	0,00	24,20	24,20	0,00

Table 2: Body composition components in percentages (%).

DC: Skinfolds; MCM: Lean Body Mass.

Another variable analyzed during the test was the resistance, which showed an increase in G1 (+16.84 watts) and a reduction in G2 performance (-33.67 watts), practically double the improvement presented in G1.

The maximum power produced at the beginning of the test and the relative drop it has suffered to the end is expressed by the fatigue index (%), ie how much power the individual loses during the 30s test, where the G1 obtained an increase of 1.8%, given that it was not in line with G2, which could be reduced by 2.89% (Table 3).

	G1 (n = 5)			G2 (n = 2)			G3 (n = 5)		
	PRE	**POST**	**DIF%**	**PRE**	**POS**	**DIF %**	**PRE**	**POS**	**DIF%**
Índex (%):	7,50	7, 50	0,00	7,50	7,50	0,00	7,50	7,50	0,00
Charge (Kp):	4,72	4,74	0,42	5,40	5,40	0,00	5,20	5,20	0,00
Power (watts):	701,7	738,1	5,19	912,1	906,8	0,59	720,2	720,23	0,00
Power (W/Kg);	11,15	11,66	4,61	12,69	12,52	1,38	12,12	12,12	0,00
Resistence (watts):	583,7	600,6	2,88	712,2	678,5	4,73	592,3	592,34	0,00
Resistence (W/Kg):	9,26	9,47	2,36	9,91	9,74	1,67	9,45	9,45	0,00
Index Fadigue (%):	34,40	36,20	5,25	42,28	39,39	6,84	37,23	37,23	0,00
Maximum power instant (s):	2,40	1,40	41,67	1,50	1,50	0,00	1,90	1,90	0,00

Table 3: Wingate test results.

Discussion

The period of supplementation to which individuals were submitted resulted in an increase in body weight in both groups, so one of the limitations of this study was the reduced number of subjects. The respective results are in accordance with another study with a 5-day supplementation period (20 g of creatine + 10 g of maltodextrin per day), where a significant increase ($p < 0.05$) in body weight of supplemented individuals was found24. Relatively significant increases ($p < 0.05$) in body weight were also obtained after 5 days of supplementation (20g creatine per day), equivalent to 60g total body weight15. Studies suggest that short periods (5-7 days) of supplementation (20 - 30g per day) are likely to cause significant increases in body weight [6,7,11,21,25].

The increases in body mass found both in the literature and in this study, but not significant, may be due to several factors, such as: (a) increase in muscle mass, (b) increase in body fat, (c) However, a recent study documented that 5 days of supplementation (20g creatine per day) caused a significant increase ($p < 0.05$) in total creatine (free creatine and phosphocreatine) combined with a concomitant increase of 18 ± 5% in muscle glycogen content ($p < 0.05$) determined from muscle biopsies (26). Each gram of glycogen that is incorporated into the muscle carries 2.7 g of water [27], therefore, the increase in muscle glycogen content from creatine supplementation causes the muscle weight to increase due to the fact that there is a greater accumulation of water in the musculature, (25 g/day for the first seven days and five grams/day for the remaining 21 days), where a significant increase was observed ($p < 0$), (05) in total body water in the first seven days (+ 1.37L), together with a 750g increase in body weight, measurements that continued to increase until the 28th day of supplementation [28].

The measured body circumference was not subject to major modifications after the period of supplementation conferred. The group supplemented with creatine and maltodextrin showed an increase in practically all circumferences collected, except for the left leg alone, whereas the group that consumed only creatine had a reduction in the perimeters of the contracted right arm, left leg and right leg. Similar data can be observed in a study, where after a 3-day supplementation period (0.35 g of creatine per kilogram of lean body mass) in male and female athletes, increases of 6.6% in thigh muscle volume were observed (3258 ± 427 mL for 3487 ± 386 mL, $p < 0.05$), values found in 5 of the 6 evaluated athletes [29]. Results consistent with those mentioned above were found after a 6-week supplementation period, combined with a periodized training for the forearm flexors, with significant increases ($p < 0.01$) in the arm muscle volume compared to the pre- and post-test + 7.9 cm^2 = 9.1%) 13, as well as significant changes ($p < 0.05$) in lean leg mass were observed after a 6-week supplementation period concomitant with strength training [30].

The body composition components measured in this study suffered considerable changes after the 5-day supplementation period, changes observed in both the creatine-only group and the concomitant maltodextrin intake group. The present results disagree with the findings of a study containing 6 weeks of supplementation, where there were no significant changes ($p < 0.05$) in the amount of body fat, even though one of the skinfolds collected, tricipital fold, suffered a significant reduction ($p < 0.01$) compared to pre and post-test (-1.2 mm = 15.00%) [13]. Another study consisting of 4 weeks of creatine supplementation (30g daily in the first two weeks followed by 15g daily in the last two weeks) did not demonstrate significant changes in the amount of body fat evaluated in the pre- and post-test periods, but were observed significant increases ($p < 0.05$) in body weight (90.42 ± 14.74 kg to 92.12 ± 15.19 kg) and in the amount of body water (53.77 ± 1.75 L for 57.15 ± 2, 01L), leading the authors to conclude that the consequent increase in body weight from supplementation resulted in the retention of water in the body [31]. In another study carried out with 6 days of creatine supplementation (4 doses of 5g/day) also found a significant difference in body weight (+1.30 ± 0.63 kg) [32].

Corresponding findings cited above are expressed in a study where creatine was ingested at low doses and for prolonged time, where the percentage of body fat was not subject to significant changes ($p < 0.05$), and among other data, the authors concluded that any amount of creatine is incapable of producing ergogenic effects [33]. Studies with long periods of supplementation were not able to produce significant changes in the body fat content of subjects tested before and after creatine intake, as well as short periods, such as 5 days of supplementation (20g per day of creatine), were not sufficient to cause significant changes ($p < 0.05$) in the percentage of body fat between the pre- and post-test (10.7 ± 3% to 11.3 ± 3%) [15]. The intake of creatine for various periods in the short and long term is plausible for changes in body composition, however, changes in the amount of absolute and relative fat is not compatible with significant changes, and the effects of supplementation with respect to body weight gain are due to variations in the structuring of the other components of the body affected by creatine supplementation.

The results expressed by G1 and in relative degree by G2 do not agree with studies concerning creatine supplementation, where an increase in the amount of lean body mass is observed after different periods of supplementation [5,9,11,21,25,33]. A 6-week study demonstrated a significant ($p < 0.01$) increase in lean body mass in the group supplemented with creatine (20g for the first five days and two grams on subsequent days) between the pre- and post-test period, equivalent to + 1.6kg lean mass [13]. Similar data were found after eight weeks of supplementation (0.3g of creatine per kilogram of body weight in the first week followed by 0.03g per kilogram of body weight in the following seven weeks), noticing significant increases in lean body mass of subjects supplemented with creatine [17]. The relative increases in the amount of lean body mass evidenced in the previous studies may be due to elevations in the amount of water and glycogen retained in the musculature, however, high rates of these compounds persist while there is creatine supplementation, being that when supplied or reduced intake daily, intracellular stores of glycogen and creatine tend to reduce [26], and 30 days after the suppression of creatine supplement, their concentrations in the body are equal to the pre-supplementation period [34,35].

For the analysis of individuals' performance, before and after the supplementation period, the Wingate anaerobic power test was used. The results obtained by the group supplemented with creatine are in agreement with the data of a study carried out for seven days of supplementation (20g per day), showing increases of 11% ($p < 0.05$) in muscle power after training period and However, three days of creatine supplementation (20 g per day) were not able to produce significant improvements ($p < 0.05$) in the performance of athletes in the Wingate test (power, peak power, average power in the first 10 seconds and average power in the 30s) [36]. Likewise, there were no significant differences in performance of athletes during sprints on a cycle ergometer (20s at maximum speed) after five days of creatine supplementation (30g creatine + 30g dextrose daily), and a significant increase was observed ($p <0.05$) in total muscle creatine of 9.5 ± 2.0% [37,38].

In contrast to the previous data, a four day supplementation experiment (20 g per day) found a significant increase ($p < 0.05$) of 3.7% in potency (W) during the Wingate test38. As well as five days of supplementation (20g per day) were plausible for significant changes ($p < 0.05$) in peak power during repetitive sprints on a cycloergometer [14]. Another study with a four-day supplementation time, but with different dosages for each group (10, 25 and 35g of creatine per day), found significant improvements ($p < 0.01$) in the mean and peak power of creatine supplemented groups during the Wingate test, data that has a significant ($p < 0.05$) correlation ($r = 0.7$) between improved peak muscle power and urinary creatine [39].

Conflicting results are documented in studies with short periods of creatine supplementation, training variables or control of dietary diets can be determining factors for whether creatine intake can cause effects on physical performance, psychological factors are also points that should be taken into consideration for a better performance in the activity proposed for analysis, so that changes in any of these components may cause the results sought by the study not to be achieved.

The fatigue index, that is, the yield drop from the maximum power instant to the end of the test, being expressed in relative values (%), means that the higher the value, the greater the power drop and/or resistance during the test. The G1 was able to raise the peak power during the test, since it was not observed in G2, however, the ingestion of maltodextrin allied with creatine supplementation caused the power levels reached by G2 to be maintained for longer high, not decreasing drastically in relation to the maximum peak power.

Conclusion

It was concluded that creatine alone was able to produce higher power gains compared to the combined maltodextrin intake, but the combination of creatine + maltodextrin increased individuals' tolerance to fatigue, ie, for physical activities that depend on a single maximal sprint the supplementation of creatine alone may be of better value, and in the case of several consecutive sprints, the intake of creatine together with maltodextrin can cause fatigue or total time to be reduced. Supplementation of creatine with maltodextrin may promote increased retention of creatine in the muscle. One of the explanations is that increased insulin concentrations stimulate retention of creatine in the muscle.

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