

# Short-term Creatine Supplementation Suppresses the Cortisol Response to a High-Intensity Swim-Sprint Workout

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**Citation:** Dobgenski V, Santos MGD, Campbell B, Kreider R (2014) Short-term creatine supplementation suppress the cortisol response to a high-intensity swim-sprint workout. *J Nutr Health Sci* 1(2): 204. doi: 10.15744/2393-9060.1.204

**Received Date:** June 27, 2014 **Accepted Date:** July 10, 2014 **Published Date:** August 20, 2014

## Abstract

The primary aim of the present study was to evaluate the effects of creatine ingestion on the metabolic hormone cortisol in male swimmers. Seventeen male swimmers ( $24.5 \pm 3.9$  years) with at least 5 years of competitive swimming experience and engaged in swimming training at least 4 times per week participated in the study. Subjects supplemented with creatine (20 g/day) + maltodextrin (1g/kg/day) or maltodextrin (1g/kg/day) only for 6 days prior to a progressive swim-sprint workout. The swim-sprint workout consisted of 8 progressive 100 meter freestyle sets starting at 65% of maximal intensity leading up to a 100% maximum capacity set on the eighth and final set. Cortisol was assessed immediately before and immediately after (within 5 minutes) the swim-sprint workout. After 6 days of creatine monohydrate supplementation, there was a significant reduction in cortisol concentrations following the progressive swim-sprint workout in the creatine + maltodextrin group ( $15.5 \pm 0.99$   $\mu\text{g/dL}$ ) as compared to the maltodextrin only group ( $18.33 \pm 2.61$   $\mu\text{g/dL}$ ). Based on these findings, it appears that creatine loading (20 grams per day for 6 days) significantly reduces the cortisol response to 100-meter freestyle swimming sets performed in a progressive intensity manner.

**Keywords:** Sports nutrition; Swimming; Exercise; Catabolic

## Introduction

Cortisol, a glucocorticoid, is a catabolic hormone which is released in response to stress and during high-intensity exercise. Cortisol is secreted by the adrenal cortex and is ultimately controlled by the hypothalamic-pituitary-adrenal axis. Specifically, the secretion of cortisol is controlled almost entirely by adrenocorticotropic hormone (ACTH) secreted by the anterior pituitary gland [1]. The catabolic effects of cortisol result in a decrease in protein synthesis and an increase in rates of protein degradation [2]. Chronically elevated levels are associated with stress- remodeling [2].

In relation to exercise metabolism, there is a direct relationship between elevations in exercise intensity and the cortisol that is released by the adrenal cortex [3,4]. During exercise, one of the primary actions of cortisol is to liberate fuel substrates (blood glucose and free fatty acids) for subsequent oxidation in active skeletal muscle. To this end, cortisol stimulates the hydrolysis of triglycerides by increasing sensitivity of adipose tissue to catecholamine-stimulated lipolysis [5]. Also, cortisol stimulates muscle protein degradation resulting in an increase in the availability of amino acids [6]. Specifically, cortisol selectively degrades type II and spares type I muscle fibers [7]. It is likely that cortisol's effect on elevating plasma amino acid concentration via proteolysis leads to the production of glucose via gluconeogenesis in the liver. Evidence for this comes from the demonstration that cortisol activates the gluconeogenic enzymes fructose 1,6-biphosphatase and phosphoenolpyruvate carboxykinase (PEPCK) [8-10].

Due to the catabolic/proteolytic nature of cortisol, as well as its association with immunosuppression [11], research has been conducted in athletes to determine the cortisol response to different training regimens [12,13] and nutritional interventions [14-19] in order to prevent elevations in cortisol. Carbohydrate supplementation has been consistently studied for its effects on the cortisol response to exercise, with some of these investigations reporting that carbohydrate intake suppresses cortisol concentrations [15,19] and others reporting no effect on suppressing cortisol concentrations [14,16-18].

In addition to carbohydrate supplementation, short-term creatine monohydrate ingestion has also been investigated for its effects on plasma cortisol concentrations during resistance exercise [20] and cycling exercise [21]. In each of these investigations, it was reported that short-term creatine supplementation did not suppress the plasma cortisol concentrations that were elicited from the exercise interventions. Few, if any studies have investigated the effects of carbohydrate with creatine monohydrate supplementation and its effects on the cortisol response following an acute bout of physical activity. The purpose of the present study was to determine if creatine monohydrate added to carbohydrate (maltodextrin) reduces cortisol concentrations as compared to maltodextrin supplementation alone following a progressive intensity swim-sprint workout.

## Methods

### Participants

Seventeen swimming athletes volunteered to take part in this study. The participants were swimming athletes (competitors under master or professional levels) from various swimming centers in the city of Curitiba/Pr-Brazil as well as swimming athletes not associated with swimming centers. The participants performed their swim training for a period of at least five years and were currently attempting to improve swim speed with a training frequency of at least four days per week. All participants were informed about the procedure and purposes before enrolling in the study and signed an informed consent document that was approved by the Ethical Committee from Federal University of Parana, Brazil.

### Experimental Design

A randomized, double blinded design was implemented in this study. Participants were required to attend the MobiDick Sport Center three times over a three-week period. During the first visit, the best time that the participant achieved on a 100-meter freestyle swim was recorded and used to set the intensity for the following two exercise sessions. During the next two visits, the participants performed a progressive intensity swim-sprint protocol (see exercise protocol below) in which blood was collected (refer to blood sampling and analysis below) one hour prior to the workout and immediately after the swim-sprint protocol. The first of these visits was conducted without supplementation (T1), and the last testing session (T2) was performed after the participants ingested creatine plus maltodextrin or maltodextrin alone for six days prior to the workout.

### Supplementation

Participants were divided into two groups: the creatine monohydrate group (CREATINE;  $n = 9$ ) was supplemented with 20g/day of creatine monohydrate and 1g/kg of bodyweight per day of maltodextrin. The control group (CONTROL;  $n = 8$ ) was only supplemented with 1g/kg of bodyweight per day of maltodextrin. Participants ingested the sports supplements for six days prior to the progressive swim protocol. Supplements were weighed with a precision scale and portions were kept into individual bags for daily use. Participants ingested the supplements in four equal doses throughout the day, with one of the doses taken 40 minutes prior to the swim-sprint protocol on the day of testing. The creatine (Option Corporation®) and maltodextrin (Probiotica®) were acquired from local sports supplement retail shops in Curitiba-PR.

### Exercise Protocol

Data collection was carried out at MobiDick Sport Center located in Curitiba-PR, in swimming pools of 25 meters. Eight consecutive 100-meter freestyle sets were performed in a progressive intensity format in the following manner [22].

- 3 sets at 65% of the best 100 meter time with 3 minutes of rest after each set
- 2 sets at 75% of the best 100 meter time with 4 minutes of rest after each set
- 1 set at 85% of the best 100 meter time with 6 minutes of rest after this set
- 1 set at 95% of the best 100 meter time with 20 minutes of rest after each set
- 1 set at maximum intensity (100% effort)

Percentages of effort were established according to the best times recorded for each athlete, which were obtained during an initial visit to the MobiDick Sport Center.

### Blood Sampling and Analysis

All biochemical analyses were completed at the Service of Clinical Analyses from the Federal University Hospital of Parana (SAC/UFPR). Blood samples were obtained through venous collection (needle and syringe) in the antecubital vein of each athlete at two different time points: at rest one hour before the beginning of the progressive swim-sprint protocol and immediately after (within 5 minutes) the swim-sprint protocol. Collected blood was assayed for cortisol, insulin, and blood glucose. Each sample of blood was separated in two tubes: one containing fluoride (4ml) for glucose determination and the other (8ml) containing a gel sifter for the analysis of insulin and cortisol. The concentration of circulating glucose was accomplished via the Glucose Hexokinase II method through the Glucose Hexokinase II Kit and ADVIA 1650 reagents (Bayer). Insulin levels were determined by immunoassay and immunometric assay methods on an Immulite 2000 automated analyzer.

### Dietary Intake

During the week of the experiment, participants were required to complete a dietary record for three non-consecutive days. Only one of the days could be on a weekend. Participants were instructed to record all food and beverages ingested (including preparation and quantity) as well as the time and place in which the food was ingested. In addition, participants were instructed to avoid foods containing caffeine during the week of the experiment due to the concerns that caffeine may suppress the effects of creatine [23].

### Statistical Analysis

The Shapiro-Wilk test of normality was applied and since the normal condition was not achieved, dependent variables were analyzed by the Wilcoxon non-parametric test. The Mann-Whitney test was used to verify significant differences between the different groups. The level of statistical significance was set at  $p < 0.05$ . Data was analyzed by SPSS 13.0 software for Windows.

## Results

### Cortisol

Cortisol concentrations were significantly decreased ( $p < 0.05$ ) in the creatine + maltodextrin group after the swim-sprint protocol as compared to resting values. In addition, the creatine + maltodextrin group realized significantly lower ( $p < 0.05$ ) cortisol concentrations following the swim-sprint protocol as compared to the maltodextrin group. Table 1 provides the raw data for cortisol concentrations under both the supplementation and non-supplementation testing sessions.

	CREATINE GROUP		CONTROL GROUP	
	PRE	POST	PRE	POST
CORTISOL REST	18,83 ± 1,78	19,45 ± 4,00	17,97 ± 0,94	**19,70 ± 1,91
CORTISOL END	17,75 ± 2,13	*# 15,50 ± 0,99	17,17 ± 1,21	18,33 ± 2,61

Table 1:  $P \leq 0,05$  (\*- pre and post the same group, #- between groups).

### Blood Glucose and Insulin

In relation to blood glucose, a significant difference was observed between groups at rest after supplementation, with the creatine + maltodextrin group experiencing a significantly lower ( $p < 0.05$ ) blood glucose level as compared to the maltodextrin only group. After the swim-sprint protocol, blood glucose levels were lower in the creatine + maltodextrin group as compared to the maltodextrin only group, but this difference did not reach statistical significance ( $p = 0.06$ ).

Regarding insulin, a significant difference was observed between groups after the swim-sprint protocol, with the creatine + maltodextrin group experiencing a significantly higher ( $p < 0.05$ ) insulin concentration as compared to the maltodextrin only group. Table 2 provides the raw data for blood glucose and insulin concentrations under both the supplementation and non-supplementation testing sessions.

	CREATINE GROUP		CONTROL GROUP	
	PRE	POST	PRE	POST
INSULIN REST	21,57 ± 23,87	14,12 ± 10,70	21,63 ± 23,81	21,51 ± 23,92
INSULINA END	11,02 ± 1,36	*# 15,78 ± 3,53	11,04 ± 1,33	10,10 ± 1,39
GLYCEMY REST	90,33 ± 4,03	*# 80,67 ± 9,05	89,00 ± 1,55	91,67 ± 5,09
GLICEMIA END	110,50 ± 17,51	† 99,33 ± 12,44	104,67 ± 12,40	116,33 ± 19,44

Table 2:  $P \leq 0,05$  (\*- pre and post the same group, #- between groups).

## Discussion

Cortisol exerts its catabolic activity by inducing lipolysis and proteolysis. Elevated cortisol activity also stimulates hepatic gluconeogenesis and increases systemic blood glucose concentrations. Because it is typically known as a stress hormone, cortisol levels are elevated progressively with increases in exercise intensity [24]. There is strong evidence that carbohydrate consumption during exercise may attenuate the increase in cortisol concentrations and its associated immunosuppression [25]. However, this observation has been reported primarily in endurance-type exercise trials [15,26,27].

In the present investigation, carbohydrate ingestion (in the form of maltodextrin) given 40 minutes before high intensity progressive swim exercise had no effect on the suppression of cortisol. Based on these findings, it may be hypothesized that carbohydrate supplementation may be beneficial in reducing the cortisol response to prolonged endurance exercise, but not short term, high intensity exercise.

However, a typical loading dose of creatine (20 grams per day for 6 days) prior to the high intensity progressive swim exercise significantly reduced cortisol elevations in comparison to maltodextrin ingestion alone. These results should not be interpreted in such a way that would minimize the importance of carbohydrate ingestion prior to exercise. Conversely, carbohydrate ingestion is essential for maintaining blood glucose levels during endurance exercise, for providing blood glucose as fuel for the central nervous system during endurance and repeated high-intensity exercise, and to offset the reductions in skeletal muscle and liver glycogen that are associated with exercise.

## Conclusion

This investigation in trained swimmers demonstrates that short-term creatine supplementation can suppress the exercise induced cortisol response during high-intensity swim sprinting. This finding may be beneficial for athletes undergoing intense training and may help prevent overtraining syndrome and assist the athlete in a more rapid recovery post-exercise. In the same way that carbohydrate supplements are used to prevent catabolism in long distance events, this study proposes that creatine supplementation may suppress the catabolic activities of cortisol during short duration, high intensity exercise.

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