

The influence of creatine use on performance of swimmers

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Abstract

The aim of this study is to examine the effects of creatine use on the performance of swimmers. The existing literature was reviewed. The studies were presented in tables. It was found that most of the studies on creatine use in swimming branch were on single sprint performance, repeated interval swimming set performance and increase in strength. Increases were found in maximal swimming time and recovery capacity. 1,52% performance increase was found in sprint swims. Increases between 2-8% were found in total work performance. There were also studies which did not report any effect of creatine on performance. One of the reasons why such studies did not report any effects is insufficient creatine loading. In swimmers who use creatine, the effects are generally seen in fat-free body weight, total body weight and amount of body water. In controlled studies conducted on swimmers, both plasma concentration increase and elevation of total creatine amount in muscles can occur with creatine supplement intake (daily about 20 gr). This increase can be positively reflected in performance. It can contribute to swimmers' aerobic and anaerobic endurance of upper and lower extremities, sprint running and sprint swim speed, maximal strength and strength continuity and recovery speed in-between repeats and post-training. Its use should be conducted in normal doses under physician control.

Keywords: Swimming, Creatine, Performance

INTRODUCTION

Today, Swimming is a situation in which the swimmers must float in a liquid like water to compete. The more velocity of the swimmers raises the more resistance of water as much as second power regardingly. Hence, swimmers need to some factors such as strength and power of muscles and improvement of performances to meet these high demands. athletes have continuously sought elixirs to enhance their performance. Creatine is one of the most commonly used dietary supplements (2). Supplementation with creatine increases an individual's total muscle creatine content (i.e. intramuscular phosphocreatine and creatine (33). A relatively large scientific body of literature has been generated over the past decade documenting the physiologic and performance effects of creatine supplementation in diverse populations (31). It is a commonly held view that creatine use supports sportive performance with a wide popularity among athletes (24).

Creatine is an amino acid synthesized primarily in the liver and stored mostly in the muscle (32).

Creatine plays a very important role in skeletal muscle, heart, brain, cells for seeing in the eyes and sperms. In high and increasing energy metabolism, creatine and creatine phosphate are physiologically very important metabolites for cells to generate cellular energy. When 20 mg creatine is taken daily, 10 times more creatine is synthesized in the body. The body can store an additional 100 mg creatine. Human organism needs daily 2 gr creatine and it is mostly synthesized in the liver (9, 26). Since its daily synthesis is not enough in the body, half of it should be taken from the outside. Half of 3-5 grams can be taken from animal protein such as meat and fish. 1 gr of creatine is isolated with 23 gr of water. Its side effect which occurs as weight increase is between 1,8-2 kg depending on the period and amount of use (6, 16). Few official toxicity studies have been conducted to assess the potential side effects of creatine supplement (3). In addition to benefits of creatine use, its possible side effects can be listed as muscle cramps, nausea, diarrhea, dizziness, gastrointestinal pain, dehydration, weight gain,

hydration, heat intolerance and fever (34). There is no well-prepared report on the side-effects of creatine supplements. It is hoped that creatine loading does not have short and long-term harmful effects on health. The only change that is found more or less continuous is the increase in fat-free body weight (21).

A great number of studies show that creatine supplement actively increases neuromuscular performance in anaerobic and intermittent exercises and that it is very useful for high power that athletes require (10). English sprinters and disabled runners who used creatine in 1992 Olympics were successful. The success of Olympics champion Linford Christie was considered to be due to creatine intake. $\frac{3}{4}$ (three out of four) swimmers who won medal in 1996 Atlanta Summer Olympics had a good reason to use creatine: because trainers and athletes believed that it worked and it was even found to work. It is estimated that more than 80% of the athletes who participated in Atlanta Olympics used creatine. Gold medals were won in national and international

competitions with creatine as natural performance improver (11).

While it was found creatine have positive effects in some studies and on some individuals, in some studies it was found that creatine have no positive effects. This means that supplement creatine intake does not cause an effect on all individuals and it can caused side-effects.

In swimming, it was not found to have positive effects on 6% of all individuals. Mostly female athletes in strength, quick strength and endurance sports believe in its effect. The aim of this study was to investigate the influence of creatine use on performance of swimmers.

INTERPRETATION OF ANALYSIS & FINDINGS

Results of some studies conducted in the branch of swimming are presented in the tables below.

In the table-1 studies about the effect of creatine supplement on single sprint in swimming is presented.

Table 1. The effect of creatine supplement on single sprint in swimming

Study	Year	Dosage+Protocol	Group	Findings
Anomasiri (1)	2004	While the creatine group received 10 gr creatine monohydrate and 30 gr orange juice every day for 7 days, control group received only 30 gr orange juice.	38 male swimmers (19 in the creatine group, 19 in the control group).	In amateur swimmers, body weight and fat-free weight increased with daily 10 gr creatine for 7 days. In addition, sprint time in the last 50 meters of 400 meters decreased significantly.
Burke et al. (4)	1996	5 gr creatine monohydrate – 2 gr sucrose (a total of 20 gr a day), 4 times a day and for 5 days. 1x 25 m sprint, 1x 50 m sprint and 1x100 m sprint. 10 minutes of active recovery, 2-3 minutes of passive recovery in-between sprints.	32 elite female (14) and male (18) swimmers in national level.	No significant performance changes was found in any of the trials. No effect on body composition.
Peyrebrune et al. (7)	2000	Daily 2x10 gr creatine (20 gr creatine) monohydrate Trainings were in the form of normal swimming training for 16 weeks.	Male swimmers in a university team (randomly 12 individuals)	Who received creatine, swimming performance time was significantly better in mixed 25 m when compared with the group who did not. While 25 meter sprint swimming performance was first 6,2 sec and later 6,0 sec in the group which did not receive creatine, it was first 6,3 sec and later 5,6 sec in the group which received creatine and this decrease was found to be statistically significant.
Dawson et al. (8)	2002	Daily 20 gr creatine monohydrate loading for 5 days, during the maintenance period, daily 5 gr creatine monohydrate was loaded for 22 days .(5 gr creatine monohydrate- 1 gr glucose polymer and 6 gr glucose polymer). Before loading, 50 meter free style with 5 minutes of active recovery and 100 m maximum speed free style sprint swimming. 3x100 m recovery swimming over 1,5 minutes of interval. Height, weight, skin fold	Randomized, single-blind. 10 male and 10 female competitive young swimmers (16 years of age), (10 samples creatine, 10 placebo).	Creatine loading did not affect body mass or composition or individual performance in the pool. No positive changes were found in sprints. After creatine intake, 30 sec. swimming bench total work score increased in the first and second trial ($p < 0.05$), but not in placebo. Post-exercise blood lactate levels were not different in 50 and 100 meter sprints after loading within the groups or between the groups. While creatine intake did not significantly improve individual performance of competitive young swimmers, it increased performance in

		thickness from 6 areas, Biokinetic swimming bench total productivity test (2x30 sec. with 10 min. of passive recovery in-between)		swimming bench test.
Havene tidis et al.(13)	1996	2 different supplement period: 5 gr creatine and 5 gr placebo with 4 months in-between, 5 times a day, for 4 days. Non-randomized, double-blind. Distance not specified.	21 elite swimmers (11 males, 10 females).	Significant improvement in competition time (2,1%) following the first supplementation period, in creatine group. More improvement in the competition time following the second period, for the creatine group (3,0%).
Mendes et al.(19)	2004	Double blind, placebo controlled. 5 gr creatine + 20 gr carbohydrate and Placebo 20 gr carbohydrate. 4x every day, 8 days, 1x 50 m sprint and 1x 100 m sprint	18 competition swimmers (12 males, 6 females, average age 19).	It was not influential on the performance of each group. Only in the creatine group, fat-free body weight, total bodyweight and body water amount were found to increase significantly. No change was found in muscle mass.
Mujika et al.(22)	1996	5 gr creatine monohydrate and 5 gr lactose (placebo) four times a day during 5-day long exercises (a total of daily 20 gr). 1x 25 m, 1x 50 m and 1x100 m sprint consisting of 300 m active recovery, 20-25 min passive recovery in-between sprints.	Randomly chosen 11 male and 9 female national or international swimmers	Body weights of the group which received creatine increased significantly with a rate of 1% (0,7 kg). No differences were found between the observed groups in terms of performance creatine. A significant decrease was found in pre-exercise 50 and 100 m distances in the creatine group.
Peyrebrune et al. (23)	1998	Randomized double blind. Daily 9 g creatine+4,5 gr maltodextrin+4,5 gr glucose for 5 days. Placebo group received 18 gr glucose daily. 1x50 yard (45.72 m) single sprint	14 national elite male swimmers and placebo (20-21 years of age).	Creatine was not found to influence single 50 yard sprint performance.
Selsby et al.(25)	2003	5 days of loading: 0,3 gr creatine per kilogram and dextrose for placebo. During maintenance period, creatine group received daily 2,25 gr creatine, while placebo group received dextrose for 9 days. Daily 2,25 gr creatine was given for 9 days regardless of the body weights of samples who were loaded with creatine.	Randomized, double blind study. 8 male and 7 female college swimmers.	There was a significant decrease in the average performance time of the creatine supplement group in 50 yard free style. Creatine load was found to positively influence 50 and 100 yard single effort sprint degrees of college 3rd league swimmers.
Thompson et al. (30)	1996	2 gr creatine and 2 gr placebo for 42 days during training. Free style: 1x 100 m sprint and 1x 400 m sprint. Rest and exercise (10 and 15 minutes of submaximal plantar flexion move). ATP and creatine phosphate concentrations were determined by using ³¹ P MRS.	Randomized, double blind placebo controlled study. 10 female university swimmers	For each group, no significant effect of creatine was found on swimming time with each sprint. The differences between groups during exercise, post-exercise and rest were not significant. No significant increase was found in fat-free body weight.

In a few studies it was found significant decreases in the average performance time of the creatine supplement group, but generally results showed that creatine has no significant effect on swimming time in sprints in a variety of different supplementation regimes and a single sprint swim does not improve following creatine supplementation. According to these studies it can be said that it is unlikely creatine supplementation would be of benefit to single sprint performance in swimming.

In the table-2 studies about the effect of creatine supplement on repeated interval performance in swimming is presented.

Table 2. The effect of creatine supplementation on repeated interval set performance in swimming

Study	Year	Dosage+Protocol	Group	Findings
Carl et al. (5)	1999	6 high intensity training. Daily 0,4 gr creatine per kg for 5 days, placebo group was given gelatine in the last 3 days (200 mg/days). The group which received creatine was given caffeine (200 mg/days) on the last day. forearm flexors and maximal interval exercise, fatigue test ankle flexion swimming tests 6x50 yard, 3 min intervals	Female swimmers and placebo group	Total strength was found to increase significantly in swimmers who received creatine and caffeine together, it was not found to increase in swimmers who received only creatine. When long rests were given within creatine repeats (>3 minutes), swimming performance was found to be influenced; however, when rest intervals were short (<30seconds), no influences were found.
Havenetidis et al.(13)	1996	2 different supplementation periods: 5 gr creatine and 5 gr placebo with 4 months interval, 5 times a day for 4 days. Non-randomized, double blind. 10x 50 m sprint with 1 minute intervals, 8x100 m sprint with 2 minute intervals and 15x100 m sprint with 40 seconds intervals	21 elite swimmers (11 males, 10 females).	Greater recovery in performance for the creatine group when compared with the placebo group in the first supplementation period. Greater recovery in the performance in second supplementation period for creatine group.
Grindstaff et al.(12)	1997	Randomized, double blind placebo controlled. Daily 21 gr. creatine monohydrate and 4,2 gr maltodextrin and daily 25 gr maltodextrin for 9 days during training. 3 x 100 m competition tempo free style swimming with 60 seconds of passive rest and 3 x 20 sec upper extremity isokinetic arm ergometry test with 60 sec of rest	18 junior (11 female and 9 male swimmers) American regional and national amateur swimmers	In the creatine group, body weight increase was not significant (0,5 kg). Fat mass and fat ratio were found to decrease. 100 m swim degree was found to be significantly faster in the first training (1,1 sec). 100 m swim degree was found to decrease swimming time in the second training, too. Improvements in swimming times in all three trainings. In the upper extremity training, work was significantly more in the creatine group when compared with the placebo group; however, no significant difference was found in the second and third sprints. Total swimming time was found to decrease in the creatine group.
Jacobs et al. (14)	1998	Double blind study Two-week long creatine intake on 50 meter (6x50 meter twice a week) and 25 yard (10x25 twice a week) on speed.	18 male and 14 female college swimmers	Swimming time was not found to decrease. Creatine supplementation was not found to affect performance development in female swimmers; however, a development of higher than 30-35 seconds was found in exercise repetition times in male swimmers.
Leemputte et al.(17)	1999	Placebo controlled 5 x 5 gr creatine intake for 4 days.	11 German swimmers (8 male and 3 female) about 18 years old who had at least 5 years of swimming training),	In sprint interval training, 1,52% performance increase and endurance development was reported in sprint swims following high dose creatine intake. Creatine supplement was not found to have an effect on either gender or 10x 25 yard intervals. In 6x50 meter series, while no effect was found in females, positive effect was found in males. Creatine supplementation was not found to affect performance development in female swimmers; however, a development of higher than 30-35 seconds was found in exercise repetition times in male swimmers.
Leenders et al. (18)	1996	Double blind randomized , 20 gr creatine and placebo for 14 days during training. Interval tests: 6x50 m swimming (with 180 sec recovery), 10x25 m swimming (with 60 sec recovery), 12x100 m (with 150 sec recovery)	Male and female university student swimmers	No difference was found between groups in 10x25 and 12x100 meter sprint times. However, significant decrease was found in 6x50 meter swimming time. As a conclusion, significant resistance was found in creatine group for speed increase in interval set swims.
Mendes and Tirapegui (19)	2004	Double blind, placebo controlled 5 gr creatine + 20 gr carbohydrate and placebo 20 gr carbohydrate. 4x every day, for 8 days. 3x3x 50 m sprint with 30 sec interval between sprints and 150 sec interval between sets.	18 competition swimmers (12 males, 6 females, average age 19).	It was not found to be effective on the performance of each group. Only in the creatine group, fat-free body weight, total body weight and body water amount were found to increase significantly. No change was found in muscle mass.
		Supplementation was implemented in two different times (with 30 days interval), 5 gr creatine and 5 gr maltodextrin 4 times a day for 6	16 national	Greater increase was found in swimming time in placebo group between 2 sprints. No significant change was found in body weight and fat percentage. While the values were similar in the

Mero et al. (20)	2004	days. 0,3 gr maltodextrin and 0,3 gr Sodium bicarbonate for each body weight kg on the test day (placebo and creatine +sodium bicarbonate). Free style: 2x100 m sprint with 10 minutes of passive rest between sprints	swimmers (8 males and 8 females, average age between 17 and 18).	first one, sodium bicarbonate group was found to have 0,9 sec better degree than the sodium bicarbonate group in the second one. Simultaneous bicarbonate and creatine supplementation increased performance in consecutive maximal swims. As a result of the test, increase was found in maximal swimming time and recovery ability.
Peyrebrune et al. (23)	1998	Randomized double blind For five days daily 9 g creatin+4,5 gr maltodextrin+4,5 gr glucose, placebo group received daily 18 gr glucose. 8x50 yard (45.72 m) sprint with intervals of 1 minute-30 seconds.	14 male national swimmers and placebo (20-21 years of age),	In the creatine group, significant decrease (2%) was found in total swim time.
Selsby et al. (25)	2001	Creatine group (0,3gr/kg) and low dose creatine group (0,07g/kg) and placebo group were given 5 days of loading and daily 2 gr maintenance in the following 9 days. Swimming bench ergometry test in 50 and 100 yrd sprint 4x50 yard 2 min rest intervals and at 20 sec maximal effort.	18 male and 13 female elite swimmers	In both groups, significant increase was found in 50 and 100 yrd high dose sprint performance. No differences were found in repeated intervals and swimming bench between groups.
Theodorou and Cooke (27)	1998	Randomized Acute creatine loading: daily 5 times 5 gr creatine for 4 days, maintenance period: 5 gr creatine and 5 gr Placebo once a day and for 8 weeks. 10x50 m sprint; 60 sec swimming time recovery. 8x100 m sprint; 2 min swimming time recovery	12 Elite swimming (8 males, 4 females) average age 17	Significant recovery (2%) was found in average swimming time following acute creatine loading. No significant difference was found between average swimming time between the end of two months and following acute loading.
Theodorou et al.(28)	1999	Randomized Acute creatine loading: daily 5 times 5 gr creatine monohydrate for 4 days, maintenance period: 5 gr creatine monohydrate and 5 gr politen glycol 4000, once a day and for 8 weeks. 10x50 m sprint; 60 sec swimming time recovery, 8x100 m sprint; 2 min swimming time recovery, 15x100 m sprint; 2 min swimming time recovery	22 national swimmers (12 males, 10 females), average age 19).	Significant recovery (1,52%) was found in average swimming time following acute creatine loading. No significant difference was found between average swimming time between the end of two months and following acute loading. Significant increase (0,6%) was found in body weight following acute creatine loading.
Theodorou et al.(29)	2005	Randomized 5 gr creatine and 5 gr creatine+500 ml glucose syrup, 5 times a day for 4 days. 10x50 m sprint; 60 sec swimming time recovery, 8x100 m sprint; 2 min swimming time recovery	10 high performance swimmers (6 males and 4 females, average age 17-18).	Significant development in swimming speed for both groups (2% for the group which received only creatine and 0,7% for the group which received creatine +carbohydrate). Swimmers mostly had weight increase. Average weight increase was greater in the creatine +carbohydrate group when compared with only creatine group. A significant and positive association was found between average speed increase and average body weight of creatine and only carbohydrate group.
Dawson et al., (8)	2002	Swimmers were tested before and after a 27-day-long supplementation. They swam 50 meter free style and after that (after 5 minutes of active rest), 100 meter free style with high speed. Blood lactate was measured before each swim and 1 minute later. With 10-minute passive recovery intervals, 30 second-long circuited bench total work was determined. Creatine loading was in the form of daily 20 gr loading for five days and daily 5 gr as maintenance for 22 days.	10 young males and 10 young females	Following a 4-week-long oral creatine intake, free style sprint swimming and swimming chest press performance was found to increase in young swimmers. Post-exercise blood lactate value was not different between groups or within groups for 50 m and 100 m sprint. Following 4-week-long supplementation, the increase in sprint performance of young competitor swimmers was not significant; however, an increase was found in swimming bench test performance.

In the studies different results was found on repeated interval set performance in different usages of creatine. Some evidence exists to support a beneficial effect of creatine supplementation on repeated exercise performance. According to some studies it can be said that using creatine alone didnt lead performance improvements.

In the table-3 studies about the effect of creatine supplementation strength in swimming is presented.

Table 3. The effect of creatine supplementation on strength increase in swimming

Study	Year	Dosage+Protocol	Group	Findings
Anomasiri (1)	2004	Daily creatine monohydrate and 30 gr orange juice for 7 days in the creatine group and only 30 gr orange juice in the control group. In addition to anaerobic strength and capacity, fatigue indexes were tested with 30 sec. Wingate arm ergometry. Sprint times in the last 50 meters of 400 meters swimming competition were taken.	38 male swimmers between the ages of 16 and 23 (19 in the creatine group and 19 in the control group)	Anaerobic strength of the group which used creatine was found to increase significantly.
Burke et al. (4)	1996	Double blind and randomized. 5 day-long loading: daily 20 gr creatine and sucrose for placebo. (5 gr creatine monohydrate – 2 gr sucrose and 5 gr polyglucose- 2 gr sucrose) four times a day for 5 days. Cycle ergometry: 2x10 sec maximal effort sprint with 10 min of rest in-between sprints, swims: a)2x10 sec, b)25m./50m. Swimming program: 1x 25 m sprint, 1x 50 m sprint, 1x100 m sprint 10 minutes of active recovery, 2-3 minutes of passive recovery between sprints	National and international 18 male and 14 female Australian swimmers.	No difference was found between work performance, peak strength or peak strength times of groups or trials.
Dawson et al. (8)	2002	Randomized, (10 in creatine group, 10 in placebo group). Daily 20 gr creatine monohydrate loading for 5 days and daily 5 gr creatine monohydrate loading for 22 days during the maintenance period. 5 gr creatine monohydrate- 1 gr glucose polymer and 6 gr glucose polymer). Bicycle ergometry: Swimming bench total work efficiency test: 2x30 sec maximal effort sprint with 10 minutes of rest in-between	Single blind. 10 male and 10 female competitor young swimmers (16 years of age),	When compared with the placebo group (2,0%), total work performance was statistically significantly higher in the creatine group (7,5%).
Grindstaff et al.(12)	1997	Randomized, double blind, placebo controlled Daily 21 gr. creatine monohydrate and 4,2 gr maltodextrin and daily 25 gr maltodextrin for 9 days. Swimming bench ergometry: 3 x 20 sec upper extremity isokinetic arm ergometry test (maximal effort sprint) with 60 sec of rest between sprints	18 junior (11 female and 9 male) American local national amateur swimmers.	Greater change was found in work performance of creatine group when compared with placebo group and a significant recovery (7,8%) was found in the creatine group only during sprint 1. No difference in peak strength between trials and groups. No significant difference was found in the second sprint (5.3%) and third sprint (0.5%). Total swimming time was found to decrease in the creatine group.
Azizi (2)	2011	5 gr x 4 dose/day x 6 days	20 female competitor swimmers between the ages of 17-26	The effects of short term creatine supplementation and anaerobic performance and sprint swimming time were assessed and statistically significant increases were found in vertical jump, bench press, sprint run and swimming speed.
Juhász et al., (15)	2009	Short-term creatine supplementation (5 days) (20 g/day x 5 days). 2 x 100 meter maximum paletted swimming test	Young elite paletted swimming athletes	Significant increases were found in dynamic strength and anaerobic strength test results of the lower extremity. It was found to increase performance in consecutive maximum maximal swimming.
Mero et al. (20)	2004	30-day-long procedure, double-blind design. Both forms (daily 20 gr) were applied for 6 days for creatine supplementation and placebo. Each treatment included placebo and creatine supplementation in 6 days. In the morning of day 7, sodium bicarbonate loading was made on placebo 2 hours before 2 x 100 m maximal free style	16 male and female competitive swimmers were randomly grouped as placebo and + creatine combination.	It was shown that creatine and supplementation group loadings positively influenced consecutive maximal swimming performance and increased performance in swimming.

swimming training with 10 minutes of passive rest (0,3 g/kg body weight).

Grindstaff et al.(12)	1997	Randomised, double blinded 21g Creatine monohydrate + 4.2g maltodextrin OR 25.2g maltodextrin 9 Days. Swim bench ergometer 3x20sec maximal effort sprints 60sec rest between sprints	18 junior female and male amateur swimmers.	Significant improvements in work performed during sprint 1 only (7.8%) for the creatine group only. No differences in peak power output between groups.
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According to Burke, creatine have no effect on strength and peak performance. The other studies showed that creatine use have positive effects on strength.

CONCLUSION AND EVALUATION

The differences between acute and chronic use of creatine significant performance improvement in sprint –interval- training of swimmers. In the sport of swimming, positive effect of creatine is expected in sprint disciplines before anything else. Strength increase occurs with the increase in muscle mass. 1-2 kg weight increase occurs in muscles with water retention. This is not tragic in swimming sport; however, it may be tragic in middle and long distance athletes. In swimming sport, a great muscle mass increase is not absolutely useful because the resistance of water increases. Anabolic doping allows higher training content. Better resting ability is recommended for better performance rather than greater muscle mass. Anabolic substances also partly cause aggression. Creatine intake causes better resting ability in intense training periods.

As a conclusion creatine supplement intake in controlled studies in swimmers can present with both plasma concentration increase and with the increase of total creatine amount in muscles and this increase can be reflected positively in performance. It can contribute to aerobic and anaerobic endurance of swimmers' upper and lower extremities, sprint run and sprint swim speed, maximal strength and strength continuation and recovery speed between repetitions and after training. It can be said that findings support that creatine supplementation is not beneficial during single sprint efforts, creatine supplementation is beneficial for improving strength and performance during repeated bouts of high intensity exercise.

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