

Efficacy of Co-Supplementation of Whey and Creatine in Sports – An Observational Study

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Abstract

The present study examined the effect of simultaneous ingestion of whey protein (WP) and creatine monohydrate (CrM) on body composition, selected measures of muscular strength and power, and risks for potential renal dysfunction. Fifteen professional athletes including nine males and six females specialized in track and field, Olympic weight lifting, and modern pentathlon volunteered to participate in the study. Subjects underwent a four-week treatment period during which they ingested both (WP) and CrM while maintaining their regular diet and training intensity and volume. Body composition and performance of one-min pull-up, one-min push up, one-min squat-to-stand, standing long jump, triple jump, and 30-s single leg lateral jumps were measured before and after the treatment. Urine samples were collected throughout the treatment to determine albumin and creatinine concentrations. No changes in body weight, muscle mass, and % body fat were noted following the treatment. The treatment, however, improved ($p < 0.05$) scores in one-min pull-up, one-min push up, one-min squat-to-stand, triple jump, 30-s single leg lateral jump tests. No differences in urinary albumin and creatinine were found throughout the treatment period. In conclusion, co-supplementation of WP and CrM for four weeks is an effective yet safe ergogenic strategy in enhancing strength and power in professional athletes.

Keywords: *Whey Protein; Creatine Monohydrate; Body Weight; Body Composition; Performance*

Abbreviation

ANOVA: Analysis of Variance; BCAA: Branched Chain Amino Acids; BMI: Body Mass Index; CrM: Creatine Monohydrate; FFM: Fat Free Mass; PCr: Phosphocreatine; SD: Standard Deviation; SPSS: Statistical Package for the Social Sciences; WP: Whey Protein

Introduction

Whey protein (WP) and creatine monohydrate (CrM) are the two dietary supplements commonly used to promote muscle strength and hypertrophy [1-4]. WP is acid soluble and thus digested quickly. WP contain enriched essential amino acids, including branched chain amino acids (BCAA) that the body needs for tissue synthesis, energy, and health. Research that focuses on protein turnover using tracer kinetic shows that WP supplementation results in a high blood amino acid peak as well as a transient rise in protein synthesis and leucine oxidation at rest [5-6]. When given in conjunction with resistance exercise, WP supplementation has been shown to increase strength and power as well as fat free mass (FFM) [1-3,7]. Such gains in strength and FFM during resistance training with WP were also greater compared with soy protein [7], casein [8], or carbohydrate [1].

Creatine monohydrate supplementation has been shown to increase intramuscular phosphocreatine (PCr) pools by up to 20%, thereby reducing fatigue [9-10]. It is suggested that an elevated intramuscular PCr would allow for an increase in the total number of contractions performed during strength training [11-13]. One of the most potent stimuli to protein synthesis in skeletal muscle is muscle contraction [14]. Therefore, a greater number of contractions over a period of time in theory should result in an increased net muscle protein reten-

tion. The beneficial effects of CrM supplementation are thought to be dependent on the extent of PCr accumulation within muscle cells [10]. However, this response can be highly variable between subjects [14]. For this reason, dietary strategies such as combining CrM with protein or carbohydrate have been used to enhance the entry of creatine into the cell [15].

To date, data regarding the effect of combined use of WP and CrM on muscle mass and strength gains is lacking despite that being a popular choice among athletes and fitness enthusiasts. Caution should be exercised as both products contains an amino group that could produce an excessive load for the kidneys to excrete them. In fact, those with a potential risk for renal dysfunction has been recommended not to use CrM at dose greater than 3 g/day [16]. Additionally, excessive intake of WP can trigger gastrointestinal discomforts [17]. Ergogenic effect of this combination also remains equivocal. Burke., *et al.* [1] reported that men that supplemented both WP and CrM had greater increases in FFM then those who supplemented with only WP, while no differences in squat strength and knee flexion torque were found between the two conditions. Cribb., *et al.* [3] failed to observe any further improvement when WP and CrM were combined as compared to the use of either product alone.

The present study was set out to examine the effect of co-supplementation of WP and CrM on body composition and selected measures of muscular strength and power and to monitor risks for potential renal dysfunction. Unlike most previous studies that used recreationally active individuals, the ergogenic effect of this combined approach was tested on a group of professional athletes specialized in track and field, Olympic weight lifting, and modern pentathlon. We hypothesized that co-ingestion of proper doses of WP and CrM would be an effective yet safe ergogenic strategy for developing strength, power, and muscle mass.

Methods

Subjects

Fifteen professional athletes including nine males and six females specialized in track and field (n = 5), Olympic weight lifting (n = 4) and modern pentathlon (n = 6) volunteered to participate in the study. Subjects were examined by a physician to rule out any contraindications to participation. To qualify, they must also be free from any sport supplements for the past 12 months. All subjects were part of elite training squads preparing for major national and international competitions in their respective sports. All experimental procedures were approved by the Institutional Review Board of Shanghai Research Institute of Sports Science for the protection of human subjects, and subjects provided their informed consent before the study. Table 1 illustrates the physical characteristics of the subjects.

Sport Events	Age (yr)	Height (cm)	Weight (kg)	BMI	% Body Fat
Sprint (n = 1)	29	165.0	60.0	22.0	20.0
Middle and long distance (n = 2)	24 ± 5.7	164.0 ± 5.7	50.5 ± 4.9	18.7 ± 0.5	17.9 ± 1.8
Field events (n = 2)	19 ± 4.7	185.5 ± 7.8	132.5 ± 16.3	38.3 ± 1.7	31.1 ± 1.7
Olympic weight lifting (n = 4)	22 ± 3.4	179.5 ± 10.5	114.0 ± 21.6	35.1 ± 3.3	24.8 ± 2.4
Modern pentathlon (n = 6)	19.5 ± 1.9	179.8 ± 4.8	69.5 ± 5.0	21.5 ± 1.2	16.0 ± 4.7

Table 1: Physical characteristics of subjects.

Data are expressed in means ± SD. BMI: Body mass index.

Experimental Protocol

This study used an one-group pre-and post-test design. Subjects consumed both WP and CrM after each training session, while maintaining their regular diets and training intensity and volume throughout a four-week period. Measurements for body composition, muscular strength and power, and blood markers of renal function were taken before and after the treatment. We used this design given our special circumstance in which forming a randomized treatment vs. placebo scenario is difficult in this small cohort of professional

athletes. On the other hand, this study is considered the first of its kind in revealing the efficacy of using sports supplements among professional athletes. The study also allowed us to evaluate risks for potential renal dysfunction because of the dual supplementation.

The supplementation as well as daily diets and training routines of the subjects were guided by sports nutritionists and strength and conditioning specialists throughout the study period. Training intensity and volume were maintained constant throughout the study period. During the first week of the study, a three-day dietary analysis was conducted to gather information regarding general nutrient intakes of the subjects. This analysis revealed that the daily energy intake (means \pm SD) was 2957 ± 681 kcal of which protein, fat, and carbohydrate were approximately 25%, 35%, and 40%, respectively.

Supplementation

Subjects were prescribed to consume WP (EAS Sports Nutrition, Golden, Colorado) and CrM (Vitargo, Kalmar Sweden) six days a week for four weeks. The daily dose for WP was determined in 0.1 gram per kg of body weight. Every serving (~25 g) of WP also contained 6 g of BCAA. Thus, if a subject weighs 100 kg, he or she will consume 10 g of WP and 2.4 g of BCAA each day. As instructed by the manufacturer, CrM was given in a regimen that began with a week of loading phase (20 g·day⁻¹) followed by a maintenance phase (5 g·day⁻¹) for the remainder of the treatment period. Both supplements were administered after each training session was completed.

Measurements

Prior to and after the completion of the treatment, subjects visited the human performance laboratory in the morning after an overnight fasting for assessing their body composition and muscular strength and power. They stayed hydrated as required by the investigators. The measurement of body composition was made by using the InBody bioelectrical impedance device (Inbody 570, InBody Inc, Seoul, Korea). With the use of segmental multi-frequency bioelectrical impedance analysis, the device was able to determine body weight, muscle mass, and % body fat accurately [18].

Performance tests included one-min pull-up, one-min push up, one-min squat-to-stand, standing long jump, triple jump, and 30-s single leg lateral jumps. These tests were to measure muscular strength and power and have been highly used as valid tools in assessing fitness and sports performance [19]. One-min pull-up, one-min push up, one-min squat-to-stand, and 30-s single leg lateral jumps were conducted in the laboratory, whereas standing long jump and triple jump were conducted outdoor on a track. All tests were preceded by a proper warm-up. The following are the brief description of how each of the six tests was administered:

- **One-min pull-up:** The subject began in the position of a straight-arm hang from a bar using an overhand (pronated) grip and then pulled the body up toward the bar until the chin is above the bar. Once this position was reached, the body was lowered to the full-hang starting position. The subject tried to complete as many pull-up as they could and the total number of pull-ups completed in one minute was recorded.
- **One-min push-up:** The subject assumed a prone position on a mat with the hands placed under the shoulders, the fingers outstretched, the legs straight and slightly apart, and the weight on the tucked toes. The subject then pushed to the up position until the arms are straight and then lowered the body by bending the elbows to a 90-degree angle. The participant then returns to the straight-arm position. The subject tried to complete as many push-up as possible and total number of push-ups completed in one minute was recorded.
- **One-min squat-to-stand:** The subject began in a squat position with the thighs parallel to the ground while keeping feet flat, the back straight, and arms against the chest. The subject then rose to a full standing position and then sit back down to the squat position again. The subject tried to complete as many squat-to-stands as possible and total number of squat stands completed in one minute was recorded.
- **Standing long jump:** The subject stood at a line marked on the ground with the feet slightly apart. The subject then took off and

landed using both feet by swinging the arms and bending the knees to provide forward drive. The distance between the line and the nearest mark in the landing area surface made by any part of the body was recorded.

- **Triple jump:** The subject ran down the track and at a line marked on the ground jumped off one foot. The subject then landed on the same foot and jumped again. The third time the subject landed on the other foot and jumped into the sand pit. The distance between the line and the nearest mark in the landing area surface made by any part of the body was recorded.
- **30-s single leg lateral jumps:** The subject began by standing on the designated testing leg with the foot at one side of the line marked on the ground. The subject then jumped laterally to the other side of line and back as quick as possible. The number of jumps completed in 30 seconds was recorded. This test was done for the right and left leg separately.

Subjects also collected their urine sample on the day prior to, one week into, on the day after, and one week after the treatment. All samples were taken in the morning after an overnight fasting. These samples were used to measure urinary albumin and creatinine concentrations by a microalbuminuria test protocol. Results were used to calculate albumin/creatinine ratio.

Statistical Analysis

Data regarding body composition, performance test scores, and urinary markers were calculated as means and standard deviation. Pre- and post-treatment comparisons for the measures of body composition and muscular strength and power were made using the paired t test. A one-way analysis of variance (ANOVA) was used to assess differences in urinary markers over four sampling time points. A *p* value of less than 0.05 was established to denote statistical significance. All analyses were carried out using the Statistical Package for the Social Sciences (SPSS Version 20, SPSS, Inc. Chicago, IL).

Results

No differences in body weight, muscle mass, and % body fat were noted during the four-week treatment period (Table 2). Co-supplementation of WP and CrM seems effective in enhancing muscular strength and power. As shown in Table 3, results of the one-min pull-up, one-min push up, one-min squat-to-stand, triple jump, and 30-s single leg (right and left) lateral jump tests were all improved significantly (*p* < 0.05) except for standing long jumps. The number of standing long jumps was trending higher during post-treatment test. However, the difference did not reach statistical significance.

Anthropometric Measures	Pre-Treatment	Post-Treatment
Body weight (kg)	85.20 ± 30.53	85.12 ± 31.15
Muscle mass (kg)	62.68 ± 14.70	62.52 ± 15.24
Percent body fat (%)	0.19 ± 0.08	0.19 ± 0.08

Table 2: Results of anthropometry measurements before and after the treatment.

Data are expressed in means ± SD.

Performance Measures	Pre-Treatment	Post-Treatment
One-min pull-up (times)	8.77 ± 4.42	9.77 ± 4.73*
One-min push up (times)	28.38 ± 10.17	30.31 ± 10.16*
One-min squat-to-stand (times)	60.83 ± 5.54	61.83 ± 6.35*
Standing long jump (m)	2.42 ± 0.18	2.55 ± 0.14
Triple jump (m)	7.54 ± 0.60	7.79 ± 0.55*

30-s single leg (left) jump (times)	59.67 ± 13.05	61.83 ± 17.64*
30-s single leg (right) jump (times)	61.83 ± 12.52	65.25 ± 17.24*

Table 3: Results of performance measurements before and after the treatment.

Data are expressed in means ± SD. * Significant difference between pre- and post-treatment, $p < 0.05$.

Results of urinary albumin and creatinine concentrations as well as albumin/creatinine ratios all fell within a normal range (Table 4). No differences in these urinary markers were found across four sampling time points. It is worth noting that two subjects experienced abnormally higher albumin concentrations post treatment. This may have explained a slight upward drift in albumin concentrations and albumin/creatinine ratios seen on the day and one week after the treatment.

Sampling Time Points	Urinary Albumin (mg·L ⁻¹)	Urinary Creatinine (mmol·L ⁻¹)	Albumin/Creatinine Ratio
One day prior to the treatment	6.63 ± 1.62	2.58 ± 0.62	2.53 ± 0.13
One week into the treatment	6.70 ± 1.85	2.51 ± 0.53	2.71 ± 0.12
One day after the treatment	7.92 ± 2.07	2.63 ± 0.86	2.92 ± 0.72
One week after the treatment	7.47 ± 1.58	2.52 ± 0.71	2.97 ± 0.35

Table 4: Urinary albumin and creatinine concentrations before and after the treatment.

Data are expressed in means ± SD.

Discussion

The salient finding of the present study is that co-supplementation of WP and CrM over a four-week period elicited favorable changes in strength and power as measured by the selected performance tests. More specifically, subjects were able to execute more pull-ups, push-ups, squat-to-stands, and single leg lateral jumps within a given time period and also to jump farther in the standing long jump test. However, body weight, muscle mass, and % body fat remained unchanged throughout the treatment period. These findings suggest that the combined use of WP and CrM for four weeks can be effective in bringing about ergogenic effects among professional athletes. However, this ergogenic strategy appears to have minimal impact on body weight, body composition, and muscle mass.

The fact that body weight, muscle mass, and % body fat remained unaffected by the treatment appears to disagree with the studies that demonstrated an increase in muscle protein synthesis following WP supplementation [20-21]. In those studies, the technique involving an isotopic tracer was used to assess the balance between rates of protein synthesis and protein degradation in the muscle, and protein synthesis is said to occur if synthetic rate exceeds degradation rate. It must be noted that the dose of WP used by those studies was twice as much as was used presently. In addition, results of these study were derived from a single exercise bout, so it remains unclear how fast such an increase in protein synthesis would result in a gain in muscle mass. Other studies did show increases in body weight and FFM as a result of WP supplementation [1-3,7]. However, these studies have used a much longer treatment period (i.e., > 10 weeks) and a much higher dose of WP (i.e., 1.5 g per kg body weight per day) [1-3]. The present study used a mild dose (i.e., 0.1 g per kg body weight per day) mainly because this substance was administered in conjunction of with CrM. It appears that if accretion of muscle protein is the goal to achieve, a longer supplementation period coupled with a higher dose of WP is needed.

The improved strength and power as measured by the performance tests can be attributable to CrM that was given currently with WP. CrM is one of the most widely studied ergogenic aids. The original premise behind CrM supplementation is two-fold. First, increased intramuscular stores of PCr function as an additional source of potential energy used to replenish ATP [22]. Second, PCr acts to buffer accumulating protons (H⁺), allowing the continuation of maximal exertion [23]. More recently, Cr supplementation was also found to be able to stimulate protein synthesis [24] and to reduce exercise induced muscle damage [25]. Most studies with the Cr dose and treatment

period comparable to that used presently reported gains in strength and power as measured by one-repetition maximum, (1-RM), vertical jump, and 40-year dash in subjects who resistance trained [26-29]. These studies also observed an increase in FFM presumably due to fluid retention because CrM can draw water into the intracellular compartment via osmosis [26,28-29]. Nevertheless, no changes in body weight and body composition were observed in the present study.

The possibility that BCAA may cause the improved strength and power cannot be ruled out. In the present study, subjects ingested approximately 2.5 g of BCAA for every 10 g of WP they consumed. BCAA, such as leucine, isoleucine, and valine, account for ~35% of the essential amino acids in muscle proteins [30]. They are catabolized via transamination and decarboxylation to form Co-enzyme A, which can then be used in various metabolic pathways involved in energy production, protein synthesis, and gluconeogenesis [31]. In addition to their potential for being used as a source of energy, recent studies suggest that BCAA supplementation can stimulate protein synthesis, thereby attenuating the exercise-induced muscle damage [32-35]. These studies also observed a relationship between BCAA supplementation and attenuated muscle soreness following exercise [32-35]. As related to the current study, it is possible that our subjects who consumed WP may have benefited from its ingredients of BCAA by being able to experience a speedier recovery from each training session. This can in turn lead to improved strength and power as measured by the selected performance tests post treatment.

Since one of the main biological roles of the kidney is to metabolize and excrete nitrogen byproducts from protein digestion, eating more protein may strain the kidneys [36]. For this reason, it is possible that high protein diets rich in whey can be a health concern that may lead to possible impaired function of the kidneys. The strain to the kidneys can be further augmented by CrM supplementation as CrM is a nitrogen containing molecule. A way of detecting this potential problem is to measure urinary albumin and creatinine levels and albumin/creatinine ratios. Albumin is a type of proteins found in the blood and important for building muscle, repairing tissue, and fighting infection. Creatinine is a waste compound produced mainly in muscles that metabolize creatine and will be excreted by the kidneys once produced. If kidney function is not normal, albumin levels and albumin/creatinine ratios will rise, whereas creatinine levels will decrease. As shown in Table 4, all these urinary markers remained consistent throughout the treatment period as well as one week post treatment. It appears that doses of WP and CrM adopted in this study are generally safe for use in a longer term such as 4 weeks. However, it is worth noting that two subjects who were on high doses of WP due to their large body weight (i.e., ~145 kg) experienced more than three-fold increases in urinary albumin levels than the pre-treatment condition.

Since this study used one-group pre- and post-test design, one may argue that the improvement seen in the performance tests could be caused by training rather than supplements. However, given that these subjects were part of elite squads that were highly trained, a window of training adaptations is rather small unless a progressive overload in training intensity and volume is applied. As mention earlier, all subjects had to maintain their training intensity and volume constant throughout the treatment period.

Conclusion

The present investigation revealed that co-supplementation of whey protein and creatine monohydrate in conjunction with resistance training can be effective in producing gains in strength and power in professional athletes. This combined supplementation approach is safe, although future studies that determine an upper limit of whey consumption seems warrant. The current study provided additional evidence that supported the use of whey protein and creatine monohydrate simultaneously among professional athletes.

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