Effect of Preexercise Creatine Ingestion on Muscle Performance in Healthy Aging Males

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Abstract

Baker, TP, Candow, DG, and Farthing, JP. Effect of preexercise creatine ingestion on muscle performance in healthy aging males. *J Strength Cond Res* 30(6): 1763–1766, 2016–Preexercise creatine supplementation may have a beneficial effect on aging muscle performance. Using a double-blind, repeated measures, crossover design, healthy males ($N = 9$, 54.8 ± 4.3 years; 92.9 ± 11.5 kg; 179.2 ± 11.1 cm) were randomized to consume creatine (20 g) and placebo (20 g corn starch maltodextrin), on 2 separate occasions (7 days apart), 3 hours before performing leg press and chest press repetitions to muscle fatigue (3 sets at 70% 1-repetition maximum; 1 minute rest between sets). There was a set main effect ($p \leq 0.05$) for the leg press and chest press with the number of repetitions performed decreasing similarly for creatine and placebo. These results suggest that a bolus ingestion of creatine consumed 3 hours before resistance exercise has no effect on upper or lower-body muscle performance in healthy aging males.

Key Words bolus, timing, muscle endurance

Introduction

The age-related decrease in muscle performance (i.e., endurance) has a negative effect on physical function (1) which subsequently decreases the ability to perform activities of daily living (18). Contributing factors for the decrease in muscle performance with aging may include changes in muscle morphology (13,20), neuromuscular function (2), oxidative stress (5,12), circulating hormones (10), nutrition, and physical activity (21). From a healthy aging perspective, interventions which improve aging muscle performance are clinically significant.

Creatine is a naturally occurring nitrogen-containing compound found in the diet primarily in red meat and seafood (22). Most creatine is stored in skeletal muscle as phosphocreatine (PCr), a high-energy phosphate involved in the rapid resynthesis of adenosine triphosphate during intense muscle contraction (22). Aging may a negative impact on high-energy phosphate metabolism (6). From a theoretical perspective, increasing intramuscular creatine from exogenous creatine supplementation should enhance high-energy phosphate metabolism (19) which could lead to greater muscle performance in aging adults. A few studies have reported that creatine supplementation increases intramuscular creatine and muscle performance in older adults. For example, Brose et al. (4) found a significant increase in intramuscular total creatine and PCr which may have contributed to the greater gains in muscle strength in healthy older adults supplementing with creatine ($5\ g \cdot d^{-1}$) during 14 weeks of resistance training compared with placebo. Furthermore, creatine supplementation (~25 g a day for 5 days) before performing single-leg knee extension repetitions to muscle fatigue resulted in a 30% increase in PCr which subsequently increased exercise time to fatigue in aging adults (≥50 years of age) (19).

The timing of creatine ingestion may be an important factor for improving aging muscle performance. For example, healthy older adults who supplemented with creatine (~8 g) before (~5 minutes) performing whole-body resistance training (3× per week, 32 weeks) experienced significant gains in muscle strength (leg press and chest press) compared with placebo (7). Furthermore, creatine supplementation (~8 g) before (~5 minutes) resistance training sessions (3× per week, 12 weeks) had a positive effect on leg press and chest press muscle strength in older adults (8). From a dosing perspective, Schedel et al. (17) showed that a bolus ingestion of creatine (20 g) resulted in peak serum creatine concentrations (50-fold) 3 hours after ingestion. Performing muscle contractions when serum creatine concentrations are highest could augment creatine uptake into muscle, possibly from exercise induced blood flow (11), which could increase muscle performance. Therefore, based on our previous findings showing a beneficial effect from preexercise creatine (7,8) and that of Schedel et al. (17) who found that 20 g of creatine maximizes serum creatine concentrations, the purpose of this study was to examine the effects of creatine supplementation (20 g), consumed 3 hours before resistance exercise, on aging muscle performance. It was

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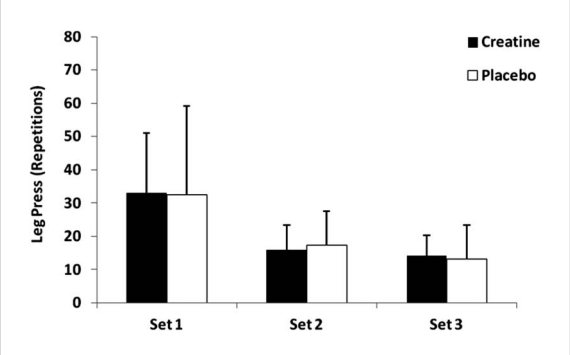

Figure 1. Leg press repetitions across 3 sets. Units are repetition number. Values are mean ± *SD*. There was a main effect for set ($p \leq 0.05$), with set 1 higher than set 2 and set 2 higher than set 3.

hypothesized that creatine would lead to greater leg press and chest press muscle performance compared with placebo.

Methods

Experimental Approach to the Problem

The study was a double-blind, repeated measures, cross-over design where participants were randomized to ingest creatine (CR: 20 g; Creapure, AlzCHem AG; Trostberg, Germany) and placebo (PLA: 20 g; Globe Plus 10 dextrose equivalent (DE) corn starch maltodextrin, Univar Canada, Ontario, Canada), separated by 7 days, 3 hours before performing leg press and chest press repetitions to muscle fatigue. Participants were instructed to refrain from physical activity, alcohol, and caffeine for 48 hours and food and drink during the 3 hours after creatine or placebo ingestion. Water was permitted ab libitum. An individual, not involved in any other aspect of the study, was responsible for randomization and administration of creatine and to participants. The creatine and placebo were similar in color, taste, appearance, and texture. Seven days separated each testing trial to ensure adequate muscle recovery between sessions.

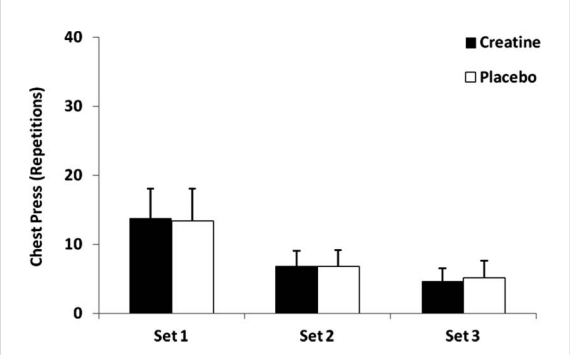

Figure 2. Chest press repetitions across 3 sets. Units are repetition number. Values are mean ± *SD*. There was a main effect for set ($p \leq 0.05$), with set 1 higher than set 2 and set 2 higher than set 3.

Subjects

Nine healthy males (54.8 ± 4.3 years; 92.9 ± 11.5 kg; 179.2 ± 11.1 cm) were enrolled in the study. Participants were not engaged in supervised resistance training for 12 weeks before the start of the study. At baseline, participants reported some level of mild-intensity (i.e., minimal effort; 0.6 ± 1.3 times per week), moderate-intensity (i.e., not exhausting; 1.6 ± 2.3 times per week), and strenuous-intensity (i.e., heart beats rapidly; 1.6 ± 2.0 times per week) physical activity. Participants were required to fill out a Physical Activity Readiness Questionnaire, which assessed their readiness for participation in the study. This questionnaire included questions related to heart conditions, angina at rest or during physical exercise, balance, and bone or joint problems which may have affected their exercise performance. If a participant indicated any of the above conditions, they were given a Physical Activity Readiness Medical Examination form which was filled out by their family physician to serve as medical clearance before starting the study. Participants were excluded if they had supplemented with creatine ≤12 weeks before the start of the study. Participants were also excluded if they had preexisting kidney or liver abnormalities, were taking medications that affect muscle biology for ≤12 weeks before the start of the study, and if they were vegetarians or smokers. Participants were instructed not to change their diet or engage in additional physical activity that was not part of their normal daily routine. The study was approved by the university ethics review board for research in human subjects at the University of Regina. Participants were informed of any risks and the purpose of the study before their written consent was obtained. The study conforms to the Code of Ethics of the World Medical Association (approved by the ethics advisory board of Swansea University) and required players to provide informed consent before participation.

Procedures

Participants were required to come into the laboratory on three separate occasions. During the first visit, a wall-mounted statue rod (Tanita Corporation of America Inc., Arlington Heights, IL, USA) was used to measure height (centimeter) and a Healthometer 349 KL electronic weigh scale (Health O Meter Inc., Bridgeview, IL, USA) was used to measure weight (kilogram). After anthropometry measurements, participants had their baseline 1-repeition maximum (1RM) leg press and chest press assessed. After 5 minutes of cycling on a stationary cycle ergometer, participants performed two warm-up sets in order: 1 set of 10 repetitions using a weight determined by each participant to be comfortable and 1 set of 5 repetitions using increased weight. Two minutes after the warm-up sets, weight was progressively increased for each subsequent 1RM attempt with a 2-minute rest interval. The 1RM was reached in 4–6 trials, independent of the 2

warm-up sets. At least 72 hours after the determination of baseline 1RM, participants consumed creatine or placebo, with water, 3 hours before performing a leg press and chest press muscle endurance test (3 sets at 70% baseline 1RM to muscle fatigue; 1 minute rest between sets). Leg press muscle endurance was assessed before chest press muscle endurance, with 5 minutes of passive rest between exercises. From previous research, the leg press and chest press had interclass correlation coefficients of 0.95 (leg press: 80% baseline 1RM) and 0.95 (chest press: 70% baseline 1RM), and coefficients of variation of 9.6 and 16.7%, respectively (9). Rating of perceived exertion (3) was recorded after the final set of the leg press and chest press. Exercise testing occurred at the same time each day. Seven days after the first assessment, participants returned to the laboratory after consuming the opposite treatment 3 hours before performing the same exercise tests.

Statistical Analyses

A 2 (creatine vs. placebo) × 3 (exercise sets) analysis of variance with repeated measures on the second factor was used to determine differences between conditions for leg press and chest press muscle endurance. A *t*-test was used to assess differences in rating of perceived exertion between creatine and placebo for the leg press and chest press. All results are expressed as mean values ± *SD*. Statistical analyses were performed using SPSS version 21.0 for Windows XP (SPSS, Chicago, IL, USA). Significance was set at $p \leq 0.05$.

Results

No adverse effects were reported from the bolus ingestion of creatine or placebo or from the muscle endurance tests. There was a set main effect ($p \leq 0.05$) for leg press (Figure 1) and chest press muscle endurance (Figure 2). As expected, there was a decrease in the number of repetitions performed across sets, with no differences between creatine and placebo. Creatine supplementation had no effect on rating of perceived exertion (leg press: creatine 9.1 ± 0.7; placebo 8.9 ± 0.6; chest press: creatine 9.0 ± 1.0; placebo 8.8 ± 0.8).

Discussion

This was the first study to examine the effects of preexercise creatine supplementation (bolus) on muscle performance in healthy aging males. Results showed that creatine had no greater effect on upper or lower-body muscle endurance. These findings are in partial contrast to that of Chrusch et al. (9) who showed that creatine supplementation (0.3 $g \cdot kg^{-1}$ × 5 days; 0.07 $g \cdot kg^{-1}$ for 79 days; ~619 g in total) and resistance training (3 sets of 10 repetitions, 3 $d \cdot wk^{-1}$, 12 exercises) increased lower-body (leg press) muscle endurance (maximum number of repetitions over 3 sets) but had no effect on upper body (chest press) muscle endurance in healthy older males (59–77 years). Furthermore, in young males, creatine supplementation (0.1 $g \cdot kg^{-1}$) for 10 days (~90 g in total) resulted in greater improvements in chest press muscle endurance (maximum numbers of repetitions over 3 sets) compared with placebo (14). Although it is difficult to compare results across studies which use different methodologies (i.e., study design, training duration, population cohort), it is possible that a single bolus ingestion of creatine (20 g) before exercise was not large enough to produce muscle performance benefits in aging males.

The lack of beneficial effects from preexercise creatine may also be related to the timing of creatine ingestion. In examining the effects of creatine supplementation (30 g) 2 hours before performing an 80-minute intermittent maximal cycling exercise, Preen et al. (16) found no effect from creatine on exercise performance or muscle PCr in young males. However, serum creatine concentrations were substantially elevated after creatine supplementation (baseline: 59.5 ± 3.9 $\mu mol \cdot l^{-1}$; after creatine ingestion: 2,348.2 ± 223.2 $\mu mol \cdot l^{-1}$). The authors speculate that the elevation in serum creatine without subsequent change in PCr indicates that the timing of creatine ingestion may be responsible for the lack of beneficial effects from creatine supplementation on exercise performance. Results of this study and that of Preen et al. (16) suggest that a bolus ingestion of creatine (20–30 g consumed ≤3 hours before exercise) has no beneficial effect on exercise performance in young or aging males. We have previously shown that preexercise creatine supplementation (~8 g) during 12–32 weeks of whole-body resistance training (3× per week) increased muscle strength in healthy older adults (7,8). Therefore, creatine may have to be consumed on a frequent basis during a resistance training program to produce muscle health benefits in aging adults.

There were several limitations to this study. First, our small sample size ($N = 9$) reduced our statistical power and may have resulted in error. Posthoc power analysis (G × Power 3.1) for the leg press interaction (partial eta squared: 0.06; effect size: 0.25; α: 0.05) yielded a power of 0.14. To achieve 80% power, a sample size of 58 participants was required. Posthoc power analysis (G × Power 3.1) for the chest press interaction (partial η^2: 0.206; effect size: 0.5; α: 0.05) yielded a power of 0.46. To achieve 80% power, a sample size of 17 participants was required. Second, no measure of high-energy phosphate metabolism, blood flow kinetics, serum creatine, or muscle fiber morphology was made which negates our ability to conclude that creatine influenced muscle biology. Third, it was assumed that all participants would respond similarly to creatine supplementation. A main determinant of any response from creatine supplementation is initial muscle creatine concentrations. Without assessing changes in intramuscular creatine from the intervention or controlling for dietary intake of creatine (i.e., red meat, seafood), the effects of creatine on aging muscle biology are unknown. Finally, participants only performed a single practice set before performing multiple sets to fatigue. This lack of familiarization may have influenced our results

as it has been shown that multiple familiarization sessions produce reliable strength results in older adults (15).

Practical Applications

In conclusion, acute preexercise creatine supplementation does not increase muscle performance or result in adverse health effects in healthy aging males. These results have application for the further development of creatine supplementation strategies which improve muscle performance and health.

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