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Research article

EFFECTS OF CREATINE, GINSENG, AND ASTRAGALUS SUPPLEMENTATION ON STRENGTH, BODY COMPOSITION, MOOD, AND BLOOD LIPIDS DURING STRENGTH-TRAINING IN OLDER ADULTS

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ABSTRACT
The effects of supplemental dietary creatine and a botanical extract consisting of ginseng and astragalus were evaluated in 44 adults aged 55-84 years participating in a 12-week strength-training program. Participants consumed creatine only (Cr), creatine plus botanical extract (CrBE), or placebo (PL), and performed bench press, lat pull down, biceps curl, leg press, knee extension, and knee flexion for 3 sets of 8-12 reps on 3 days per week for 12 weeks. The 1-repetition maximum for each exercise, body composition (full-body DEXA), blood lipids, and mood states were evaluated before and after the intervention. Training improved ($p < 0.05$) strength and lean mass for all groups, however greater gains were observed with Cr and CrBE compared with placebo (but no difference was found between Cr and CrBE). Only CrBE improved blood lipids and self-reported vigor, and the CrBE group lost significantly more body fat and gained more bench press strength than Cr. These results indicate that strength and lean mass gains achieved by older adults participating in a strength training program can be enhanced with creatine supplementation, and that ginseng and astragalus may provide additional health and psychological benefits. However, these herbs do not appear to have an additive effect on strength and lean mass gains during training.

KEY WORDS: Exercise, aging, creatine loading, strength training, dietary supplements.

INTRODUCTION

Creatine is a naturally occurring compound that is found in the skeletal and cardiac muscles, and exogenous creatine feedings can add to the body's total creatine pool (Harris et al. 1992). The ability of supplemental creatine monohydrate to enhance skeletal muscle strength has been the subject of numerous studies in the last decade. It has been shown to increase peak strength, mean power output, total work output and peak torque, as well as performance in a variety of sports that utilize the ATP-PC energy pathway to a significant extent, in young adults (Balsom et al. 1993; Birch et al. 1994; Greenhaff et al. 1993; Plisk and Kreider 1999; Ziegenfuss et al. 2002). Studies have also suggested that creatine monohydrate is an anabolic compound via its effects on decreasing muscle protein breakdown (Parise et al. 2001) and/or increasing intracellular water levels (Ingwall et al. 1974).

Because of its ability to increase muscle mass and improve performance, creatine supplementation has been proposed as a method to attenuate age-associated muscle loss and functional capacity. Indeed, the rapid loss in muscle strength and muscle mass in adults after the age of 50 is well known (Larsson et al. 1979; Rogers and Evans 1993). In this regard, several studies suggest that creatine supplementation may help older adults to better retain strength and lean mass as they age. Smith et al. (1998) found that creatine supplementation increased resting phosphocreatine levels in adults aged 50 and older twice as much as in a younger group, restoring the older group's level of phosphocreatine resynthesis to the same level as the younger participants. One week of creatine supplementation has been found to increase muscle strength, body mass, and fat free mass in active older men aged 59 to 72 years (Gotshalk et al. 2002) and increase skeletal muscle strength of chronic heart disease patients aged 43 to 70 years (Gordon et al. 1995). Chrusch et al. (2001) reported that creatine supplementation enhanced strength and lean mass following 12-weeks of training in older men aged 60 to 84 years. A recent study also reported that creatine supplementation enhanced the increases in strength and muscle mass during 14-weeks of resistance training in older adults. In this study, creatine supplementation resulted in a greater increase in fat-free mass, isometric knee extension strength, and isometric dorsiflexion strength compared with placebo (Brose et al. 2003). However, there are studies that have not found these effects (Bermon et al. 1998)

Creatine is not the only dietary supplement that may provide ergogenic and health benefits. *Panax ginseng* (Chinese or Korean ginseng) has been shown to have similar properties under certain circumstances. McNaughton et al. (1989) noted increases in pectoral strength, quadriceps strength, and post-exercise recovery following dietary supplementation with ginseng root powder. Forgo et al. (1981) observed that a ginseng extract improved subjective assessments of mood, concentration, and vitality. Also, *Panax quinquefolius* (American ginseng) extract, which has been shown to enhance the immune system and have anti-stress properties in mice, exhibits effective antioxidant activity by both chelation of metal ions and scavenging of free radicals (Kitts et al. 2000). *Astragalus membranaceus* extracts may intensify this process, further enhancing the immune response (Zhao et al. 1990). Research has also shown that astragalus can lower total cholesterol (TC), low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) and body fat in rats (Li et al. 1999; 2000; Lu et al. 1997). Up to this point, the research on astragalus has been limited to mice, rats, and guinea pigs.

Like so many dietary supplements, the research regarding ginseng and astragalus indicates a wide variety of conflicting results (Bahrke and Morgan 2000; Bucci, 2000). Some studies note a lack of effectiveness, while others show clear benefits. While there appears to be an association between the ginseng studies showing the greatest effectiveness and those that used extracts or high dosages, the existing data on these herbs is less than compelling. Given the potential for ginseng and astragalus to provide health benefits, the purpose of this study was to compare the effects of a formulation consisting of panax ginseng, panax quinquefolius, astragalus membranaceus, and creatine monohydrate with the effects of creatine monohydrate alone on strength, muscle size, immune function, blood lipids, and mood state in older adults who were engaged in a 12-week strength training program.

METHODS

Participants

Following Human Subject Review Board approval, 44 (21 male, 23 female) participants aged 55-84 were recruited using fliers and newspaper advertisements. Participants included faculty, staff, and retirees of the university as well as individuals from the local community. The nature, purpose, and attendant risks involved in the study were carefully explained to each participant before their written consent to participate was obtained. In addition, all participants were required to secure the informed consent of their physician. Participants were in good health as determined by medical history profiles. All women had been post-menopausal for at least five years. None reported the use of tobacco or diuretics, and all regularly consumed meat in their diet. To compensate the participants for their time and effort, they received a free membership in the university's older adult exercise program for the semester subsequent to the study's completion. Participants were asked to continue normal activity and eating routines during the course of the study. Participants were also asked to notify the researchers if they changed their intake of any medications or dietary supplements, including vitamin and mineral supplements.

Nutritional supplementation

Participants were stratified by age and sex prior to random assignment in a double-blind manner to one of three groups: (1) creatine only (n = 15); (2) creatine plus a botanical extract (n = 15); and (3) placebo (n = 15). The supplements were provided in the form of capsules by an FDA-registered, pharmaceutically licensed facility (Phoenix Laboratories, Hicksville, NY). Each participant was provided a numerically-coded plastic container with enough capsules for one month. New containers were distributed when individual allotments were nearly depleted. In this manner, the researchers were able to determine if individual participants were consuming the supplements according to schedule.

Participants were instructed to ingest two capsules of the assigned supplement with breakfast, lunch, and dinner to achieve their daily intake. The 'creatine only' group consumed 3 grams of creatine a day, an amount approximately 3-fold greater than a typical omnivorous dietary intake. Creatine is often supplemented at a rate of 20 grams per day for approximately one week to elevate muscle creatine levels up to 20%. Following this ‘loading phase’, supplementation often continues at a rate of 2-5 grams per day for an additional 30 days to maintain creatine concentration in the muscle (Bemben and Lamont, 2005). Hultman and colleagues (1996) have found that similar increases in muscle creatine concentration are achieved over a period of 28 days when creatine is ingested at a rate of 3 grams per day without a ‘loading phase’. Although more gradual, this approach appears to be as effective as acute ingestion of high doses followed by a low-dose maintenance phase (Hulltman et al., 1996). The 'creatine plus botanical extract’ group consumed a patented blend of 3 grams of creatine plus 1.5 grams of botanical extract a day (US Patent 6,465,018). The 'placebo' group consumed maltodextrin capsules. The botanical extract consisted of a unitary aqueous extract made from the roots of *panax ginseng*, *panax quinquefolius* and *astragalus membranaceus*. It had phytonutrient concentrations that exceed those currently available commercially, including 10% ginsenosides for the ginseng fraction and 1% flavonoids for the astragalus fraction. The extract was produced by blending all three herbs prior to initiation of the low-temperature extraction process. Composition of the capsules was verified by the manufacturer.

Testing protocol

Participants then visited the laboratory on five separate occasions for pre- (baseline) intervention testing. During the initial visit, participants received information on the study and were given the forms (i.e., consent forms, medical history, emergency information, parking permit application) that needed to be completed and returned. On the second visit, participants reported for overnight-fasted blood sampling. On the third visit, they completed the mood state survey and the DEXA scan was performed. On the fourth and fifth visits, the 1-RM assessments were performed. Post-intervention testing was performed in a similar manner.

Body composition

DEXA measurements were taken per standard protocol for the Hologic QDR 4500 Elite (Bedford, MA). DEXA has been shown to be a very reliable (r = 0.99) and precise method (coefficient of variation <1%) for assessing body composition (Fuller et al., 1992; Kellie, 1992; Mazess 1990). Quality control (QC) calibrations were conducted before each scan using a Hologic spine phantom and values were verified to be within ±1 standard deviation from the reference mean as determined by Hologic for the unit. Each participant was clothed in a hospital gown with all clothing and accessories (e.g., jewelry, hair clips, etc.) removed. They were positioned in the supine position on the scanning table where they remained motionless during the seven-minute scanning procedure. Hologic QDR 4500 software was used to quantify muscle, fat, bone mineral content, and bone mineral density of the whole body.

Blood chemistry

Blood samples (10 ml) were obtained between 0600 and 0800 after a 12-h overnight fast from an antecubital vein in the forearm with a needle and vacutainer set-up. Samples were analyzed for triglycerides, and cholesterol (total, HDL, VLDL, LDL) counts and ratios by an outside laboratory (LabCorp, Burlington, NC).

Mood state

The Profile of Mood States (POMS) was used to assess affective (mood) states during the previous week (McNair et al. 1981). The POMS consists of 65 adjectives rated on a 5-point scale to determine anxiety, depression, anger, vigor, fatigue, and confusion.

Muscle strength

In an effort to minimize learning effects of the strength testing protocols, a familiarization session was conducted prior to when the 1-RM assessments were administered. The familiarization session consisted of teaching specific exercise techniques and providing submaximal practice for each exercise. The 1-RM was then determined twice (separated by 2-3 days) for bilateral knee extension, bilateral knee flexion, bench press, and bilateral arm curl. The greater of the two 1-RM measurements was used for analysis. To minimize fatigue resulting from repetition, each test was begun at a weight near a predicted maximum based on the practice session. All exercises were repeated at a higher weight increment, with approximately 90 seconds of rest between repetitions, until failure occurred despite verbal encouragement. Failure was reached when the participant failed to lift the weight through the entire range of motion on at least two attempts spaced 90 seconds apart.

Strength training program

The participants participated in a strength training program designed to target both the upper and lower body. Training took place in the university recreation complex weight room on three days a week for 12 weeks between the hours of 6:00 and 9:00 AM. Due to facility scheduling during the winter holidays, participants took one week off at the midpoint of the study (i.e., after 6 weeks), however they still continued to consume the supplement during this week. The training program consisted of bench press, lat pull down, biceps curl, leg press, knee extension, and knee flexion for 3 sets of 8-12 repetitions on weight-stack machines. Initial resistances were set at 70% of the 1RM and the resistance was increased when the participant was able to complete 12 repetitions of an exercise. Approximately two minutes of rest were allowed between each set. Proper form with full range of motion was encouraged for the performance of each exercise. Participants performed exercises consisting of large muscle groups (i.e., bench press, lat pull down, leg press) before small muscle group (i.e., knee extension/flexion, arm curl) exercises. Upper and lower body exercises were performed in an alternating order to provide additional recovery. The resistance and number of repetitions were recorded for each set to allow the researchers to monitor progress on a daily basis.

Statistical analysis

The statistical package, SPSS for Windows 10.0 (SPSS, Chicago, IL) was used for all statistical procedures. The data are presented as mean ± standard deviation. Percent changes from pre to post were calculated from the differences in the means. One-way ANOVA on the pre-test scores revealed that the groups were no different for any dependent variable prior to training/supplementation. Subsequently, 3 x 2 (Group x Time) repeated measures ANOVA was used to determine the differences between supplement groups (over time) on each of the dependent variables. A *P*-value, set *a priori*, of less than 0.05 was considered statistically significant. When a significant *F*-score resulted, a Tukey *post hoc* test was used to determine the nature of pair-wise differences.

RESULTS

Training resulted in significant strength improvements for all groups (Table 1). For the

Table 1. Effects of supplementation on 1-RM muscle strength. Data are means (±SD).

	Creatine n = 15		**Creatine + BE n = 14**		**Placebo n = 15**	
	Pre (kg)	**Post (kg)**	**Pre (kg)**	**Post (kg)**	**Pre (kg)**	**Post (kg)**
Leg Press 1 RM	77.3	122.7 *	82.5	137.8 *	68.4	99.4
	(33.6)	(43.2)	(30.8)	(54.7)	(26.0)	(33.9)
Knee Extension 1 RM	57.8	93.4 *	63.0	104.7 *	50.5	64.5
	(25.6)	(42.0)	(31.8)	(48.7)	(16.6)	(28.6)
Knee Flexion 1 RM	36.9	57.3 *	41.1	68.0 *	31.8	44.5
	(14.2)	(22.2)	(20.4)	(32.4)	(12.6)	(16.6)
Bench Press 1 RM	35.1	58.3	38.3	70.9 *†	31.5	50.6
	(14.9)	(23.7)	(18.8)	(36.0)	(11.3)	(17.6)
Lat Pulldown 1 RM	40.3	57.0 *	45.1	63.3 *	34.8	45.7
	(12.5)	(19.6)	(16.5)	(22.4)	(10.5)	(15.8)
Arm Curl 1 RM	23.6	29.4 *	26.2	32.9 *	23.3	25.2
	(7.4)	(9.8)	(10.2)	(13.0)	(6.9)	(7.2)

* $p < 0.05$ compared with Placebo Group
† $p < 0.05$ compared with Creatine Group

Table 2. Effects of supplementation on body composition. Data are means (±SD).

	Creatine n = 15			Creatine + BE n = 14			Placebo n = 15		
	Pre	**Post**	**% Change**	**Pre**	**Post**	**% Change**	**Pre**	**Post**	**% Change**
TBM (kg)	77.2 (13.5)	79.2 ‡ (13.0)	2.6	79.0 (12.7)	79.5 (12.7)	0.6	74.5 (13.5)	75.0 (11.5)	0.7
Fat Mass (kg)	25.8 (3.5)	24.3 (3.4)	-5.8	25.1 (7.7)	22.7 *† (7.8)	-9.6	27.1 6.4	25.6 (6.6)	-5.5
% Fat	31.9 (7.8)	32.1 (6.7)	0.6	33.9 (6.0)	29.3 *† (8.6)	-13.6	36.6 (7.8)	35.1 (8.4)	-4.1
Lean Mass (kg)	49.2 (11.7)	50.9 * (12.0)	3.5	50.8 (9.8)	52.8 * (11.2)	3.9	45.1 (9.3)	45.8 (9.7)	1.6
BMD ($mg·cm^{-3}$)	1.15 (0.18)	1.17 (0.12)	1.7	1.23 (0.15)	1.26 (0.17)	2.4	1.15 (0.13)	1.17 (0.12)	1.8

TBM = Total Body Mass, BMD = Bone Mineral Density. * $p < 0.05$ compared with Placebo Group, † $p < 0.05$ compared with Creatine Group, ‡ $p < 0.05$ compared with CrBe Group.

CrBE, Cr, and PL groups, leg press improved 67, 59, and 45%; knee extension improved 66, 62, and 28%; knee flexion improved 66, 55, and 40%; bench press improved 85, 66, and 61%; lat pull-down improved 40, 41, and 31%; and arm curl improved 36, 25, and 8%, respectively. Compared with PL, CrBE had greater ($p < 0.05$) increases in all 1-RM measures, and Cr had greater increases compared to PL in all except the bench press. In all exercises except one (lat pull-down), gains in the CrBE group were larger than in the Cr group. However, none of these differences reached statistical significance except for the bench press.

The Cr group experienced a 2 kg increase in total body mass which was significantly greater compared with the other two groups which both experienced non-significant increases of approximately 0.5 kg in total body mass (Table 2). Fat mass was significantly reduced in all three groups as a result of the training program, however the CrBe group lost significantly more total fat (2.4 kg decrease) and relative fat (33.9% to 29.3%) compared with the other groups ($p < 0.05$). Lean mass also increased significantly in all groups as a result of training. Increases in lean mass were significantly greater for the Cr (3.5%, 1.7 kg increase) and the CrBE (3.9%, 2.0 kg) groups compared with the PL group (1.6%, 0.8 kg), but Cr and CrBE were not different from each other. Although each group experienced increases in bone mineral density, these changes were not statistically significant.

Interestingly, the botanical extract had a cholesterol-lowering effect (Table 3). Compared with PL and Cr, CrBE significantly reduced their levels ($mg·dl^{-1}$) of total cholesterol, LDL, VLDL, triglycerides, and LDL/HDL ratio (Table 3). In contrast, changes in blood lipids for the PL and Cr groups were not statistically different.

Results from the POMS (Table 4) indicated that none of the groups experienced a change in their self-reported levels of anxiety, depression, anger,

Table 3. Effects of supplementation on blood lipids. Data are means (±SD).

	Creatine n = 15			Creatine + BE n = 14			Placebo n = 15		
	Pre (kg)	**Post (kg)**	**% Change**	**Pre (kg)**	**Post (kg)**	**% Change**	**Pre (kg)**	**Post (kg)**	**% Change**
Total Chol	202.0 (21.4)	194.3 (22.1)	-3.8	207.1 (36.7)	186.7 * (37.2)	-9.9	207.1 (36.7)	186.7 * (37.2)	-9.9
HDL	60.1 (14.6)	58.0 (13.9)	-3.5	66.5 (11.5)	63.9 (14.1)	-3.9	63.1 (16.3)	60.0 (16.6)	-4.9
LDL	117.1 (27.4)	113.6 (23.8)	-3.0	114.6 (32.3)	100.7 * (31.8)	-12.1	123.9 (32.6)	123.1 (33.5)	-1.6
VLDL Chol	23.8 (8.4)	21.9 (5.0)	-8.0	25.1 (13.0)	20.6 * † (8.8)	-17.9	27.2 (8.8)	29.3 (9.3)	7.7
Triglycerides	121.8 (41.7)	111.4 (25.2)	-8.5	127.7 (64.3)	104.9 * † (44.1)	-17.9	137.9 (44.0)	149.4 (45.0)	8.3

Chol = Cholesterol. * $p < 0.05$ compared with Placebo Group, † $p < 0.05$ compared with Creatine Group.

fatigue, or confusion as a result of the training and supplement program. However, self-reported levels of vigor did improve in the CrBE group compared with the Cr and PL groups.

Table 4. Effects of supplementation on vigor

	Pre	Post
Creatine (n = 15)	22.6 (5.4)	22.5 (6.2)
Creatine + BE (n = 14)	18.5 (4.7)	22.0 (4.1) *
Placebo (n = 15)	19.7 (4.1)	19.5 (2.6)
Total (n = 44)	20.2 (4.9)	21.2(4.7)

Time ($p = 0.084$), Group x Time ($p = 0.028$)

Side effects reported after the completion of the study (Table 5) suggested a higher incidence of abdominal bloating in the Cr group (reported by 5 subjects) compared with the CrBE (0 subjects) and PL (2 subjects). However, water retention and intestinal gas were reported by some of the participants using the supplements containing creatine, while none of the participants in the PL group reported such an effect. For all other self-reported side-effects, including constipation, diarrhea, muscle cramp, nausea, and muscle spasm, the PL group had a similar level of side-effect reporting (i.e., plus or minus one report) compared with the supplement groups, or they reported a higher level of incidence (i.e., diarrhea, nausea) while taking the PL. However, in all cases these side effects never prevented participation in the training program, and were only temporary (i.e., only lasted a day or two).

DISCUSSION

The main objective of this study was to determine the effects of a strength training program combined with chronic (i.e., 12 weeks) Cr and CrBE supplementation on strength, body composition, blood lipids, and mood in older adults. The major findings of this study were: 1) the strength training program resulted in significant improvements in strength and lean mass regardless of dietary supplement, however, gains were greater for the Cr and CrBE groups, 2) in contrast to the Cr and PL groups, strength training combined with CrBE supplementation improved lipid profiles (i.e., reduced total cholesterol levels by 10%, LDL levels by 12%, and VLDL triglyceride levels by 18%); and in contrast to the Cr and PL groups, strength training combined with CrBE supplementation decreased total fat mass by 2.4 kg (10%), and enhanced self-reported levels of vigor.

The present study supports other studies indicating that older adults can undertake intense strength training without undue risk of injury and that intense strength training does increase strength in this population. Obviously, finding an ergogenic and anabolic effect in these older adults is noteworthy considering that each of the participants was over the age of 50 years, an age after which loss of muscle strength and muscle mass in adults has been well documented (Larsson et al. 1979; Lexell et al. 1988; Rogers & Evans 1993). The results from the current study support some, but not all, studies that have examined the effects of creatine supplementation combined with strength training in older adults. Creatine supplementation has been shown to not affect strength and body composition following eight weeks of training in older men and women aged 67 to 80 years (Bermon et al. 1998). However, it has also been demonstrated that supplementation enhances strength and lean mass following 12 weeks of training in older men with an average age of 70 years (Chrusch et al. 2001). These authors reported an increase of 50 kg in maximal leg press strength and an increase of 3.3 kg in lean tissue for those consuming a creatine supplement. These changes are only slightly higher than improvements observed in the current study for those consuming only creatine (i.e., Cr group) who demonstrated a 45.2 kg increase in leg press strength and 1.7 kg increase in lean body tissue. These results suggest that long-term dietary creatine supplementation may be an effective strategy to attenuate losses in muscle strength and lean tissue that are associated with aging.

Although the mechanisms governing the ergogenic and anabolic effects of creatine are not entirely understood, several theories have been

Table 5. Self-reported side-effects.

	Creatine	Creatine + BE	Placebo	Total
Abdominal Bloating	5		2	7
Constipation	1			1
Diarrhea	2		3	5
Muscle Cramp	1		1	2
Nausea		1	3	4
Muscle spasm	2		1	3
Water Retention	2	1		3
Intestinal gas	2	3		5

proposed. Using electrically evoked contractions of the knee extensors and serial (0, 20, 60, 120 s) biopsies, Greenhaff et al. (1994) demonstrated improvements in phosphocreatine resynthesis during recovery following five days of creatine supplementation. Some have also suggested that creatine supplementation may enhance recovery during rest periods following repeated efforts (Birch et al. 1994; Balsom et al. 1993). If creatine does enhance recovery between repeated efforts (e.g., sets of strength training exercises), it may have allowed those in the present study who were consuming the creatine supplements to engage in the strength training exercises at a higher intensity compared with the PL group. This higher level of training intensity may have, in turn, led to greater strength and lean mass gains as described by Volek and colleagues (1999). In addition to the recovery theory, Bessman and Savabi (1990) have suggested that creatine, via interaction with phosphocreatine, can increase protein synthesis and influence muscle hypertrophy. Others have suggested that creatine supplementation may increase myosin heavy chain synthesis following a 12-week strength training program with young adult males who ingested creatine throughout the length of the program (Volek et al., 1999; Willoughby and Rosene, 2001). Given the 12-week period of supplementation in this study, a morphological explanation is possible. In addition, as has been suggested for caffeine, creatine may have multifactorial ergogenic effects, affecting tissues other than skeletal muscle (e.g., nervous system). A final untested possibility is that as the creatine pool increases there is a concomitant increase in functional cross-bridges within the myofibrils (Ziegenfuss et al. 2002). Further research is needed to determine whether any of these reasons, alone or in some combination, or perhaps other unidentified theories, are responsible for the ergogenic and anabolic effect observed with creatine supplementation in older adults.

While others have examined the potential benefits of creatine in older adults, this is the first study to evaluate the effects of creatine in combination with ginseng and astragalus. Evaluating the direct effects of individual herbs when consumed in combination is difficult, particularly because the potential effects of these herbs on creatine absorption/transport are unknown. Additionally, comparing these results directly to those of other studies is difficult due to the lack of consistency between ginsenoside contents within various herbal preparations. However, some conclusions can be made based on previous studies that have examined these herbs.

Although some have suggested that multiple components of the ginseng root can produce effects via a variety of physiological pathways (Attele et al. 1999), few controlled clinical trials examining this herb's effects on performance exist, and those that have been performed provide conflicting results with some researchers reporting improved strength (McNaughton et al. 1989) and others reporting no beneficial effects (Engels et al. 2003) following prolonged ingestion of ginseng root powder.

Strength and lean tissue changes in the current study were not significantly different between the Cr and CrBE groups. However, results indicated consistently greater improvements in the CrBE group, suggesting the existence of some potential benefits associated with the botanical extract that merit further investigation. Specifically, the CrBE did tend to have greater strength gains compared with the Cr group, gained 0.3 kg more lean mass than the Cr group, and achieved a slightly higher increase in bone mineral density. Furthermore, the CrBE group experienced a significant reduction (2.4 kg) in body fat mass compared with the CrBe and PL groups while participating in the same exercise training program. Given these observations, it is possible that further work may reveal more optimal dosage levels that can induce further changes in strength and body composition.

The 10% reduction in total cholesterol, 12% reduction in LDL, and 18% reductions in both VLDL and triglycerides in the group consuming creatine in combination with the botanical extract are surprising, and suggest that some component of the extract had a hypolipidemic effect. Although an interaction with creatine can not be ruled out, it is likely that these changes can be attributed to the botanical extract as similar changes were not observed in the group consuming creatine alone. Based on previous research in mice, rats, and guinea pigs that found reductions in total cholesterol, LDL, VLDL and body fat with astragalus (Lu et al. 1997; Li et al. 1999; Li et al. 2000), we believe that these changes in blood lipids can be ascribed to the astragalus component of the botanical extract. As this is the first study to indicate hypolipidemic effects and fat loss in older adults consuming astragalus, it is prudent to conduct additional studies to determine the potential benefits of this herb when consumed alone and in combination with other constituents.

In terms of psychological parameters, none of the supplements had an effect on anxiety, depression, anger, fatigue, or confusion as determined by a subjective questionnaire. However, an increase in vigor was found in the CrBE group.

These results are in agreement with Forgo et al. (1981) who found improvements in assessments of mood, concentration, and vitality following ginseng supplementation. Therefore, in addition to the improvements in blood lipids, the botanical extract may provide an important psychological benefit for older adults.

Despite a lack of evidence from several hundred placebo-controlled, double blind studies, anecdotal reports of side-effects associated with creatine supplementation are common. However, the side-effects reported by participants consuming either of the supplements containing creatine in the current study were limited to minor issues (i.e., abdominal bloating, water retention, intestinal gas). Interestingly, although abdominal bloating was the most commonly reported side-effect in the Cr group, there were no reports of bloating associated with the creatine supplement combined with botanical extract, and two reports in the PL group. Although the method for identifying side-effects was a qualitative questionnaire and we could not determine the mechanism for these side-effects, it does appear that the reported side-effects are related to gastro-intestinal disturbances.

CONCLUSIONS

In summary, this study confirms that strength and lean mass can be gained by older adults engaged in a strength training program. The results indicate that these gains can be enhanced with daily, low-dose creatine supplementation. These benefits associated with creatine supplementation may be attributed to greater recovery between sets of weight training exercise, enhanced protein synthesis, and / or some other mechanism. Furthermore, the data suggest that older adults participating in a strength training program can gain additional health and psychological benefits, including lowering cholesterol levels and improving self-reported levels of vigor, when consuming creatine combined with a botanical extract consisting of *panax ginseng*, *panax quinquefolius* and *astragalus membranaceus*. However, further research on the use of creatine as an ergogenic and anabolic aid, and the ability of ginseng and astragalus to act as hypolipidemic agents and enhance vigor, in older adults is needed.

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KEY POINTS

- Strength and lean mass can be enhanced with creatine supplementation in older adults participating in a strength training program
- Ginseng and astragalus do not appear to provide any additive effect on strength or mass
- Ginseng and astragalus may provide additional health and psychological benefits such as lowering cholesterol levels and improving self-reported levels of vigor

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