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Effects of a carbohydrate and protein recovery beverage on performance in trained weightlifters.

Efecto de una bebida con carbohidratos y proteínas sobre el rendimiento de levantadores de peso entrenados.

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Abstract
INTRODUCTION: Previous investigations have examined nutrient timing with untrained subject and less is known about effects in trained subjects.
OBJECTIVES: The purpose of this study was to examine the effects of a carbohydrate and protein supplement (CHO+PROT) on performance measures in trained weightlifters.
METHODS: 10 trained weightlifters (30.8±5.1 years, 177.4 ±4.0 cm, 94.3 ± 12.4 kg, training age = 5.3 ± 2.9 years) completed a 12 week training program utilizing block periodization. Using a double blind placebo design, jump height, scaled peak power measured in vertical jumps and peak force and rate of force development measured in isometric mid-thigh pulls were compared between groups using a series of 2x4 (group x time) repeated measures ANOVA's.
RESULTS: No significant differences ($p > 0.05$) were observed between treatment and placebo groups in respect to measures of jump height and peak power with weighted and unweighted jumps. Likewise, no statistical differences ($p > 0.05$) were observed for peak force or rate of force development with isometric mid-thigh pulls.
CONCLUSION: These findings indicate that a CHO+PROT supplement provided no additional performance benefits compared to a placebo within a 12 week block periodization protocol in trained weightlifters.

KEYWORDS
supplementation; weightlifting; block periodization

Resumen
Introducción. En estudios previos se han investigado las pautas nutritivas en sujetos no entrenados; en sujetos entrenados hay menos información.
Objetivos. El objeto de este estudio fue examinar los efectos de un suplemento con carbohidratos y proteínas (CHO+PROT) sobre el rendimiento de levantadores de peso entrenados
Métodos. Diez levantadores entrenados (edad 30,8±5,1, 177.4 ±4.0 cm, 94.3 ± 12.4 kg, tiempo de entrenamiento = 5.3 ± 2.9 años) completaron un programa de doce semanas usando bloques periódicos. Con un diseño doble ciego con placebo se compararon los grupos en series de 2x4; se analizaron los distintos parámetros específicos del deporte. Para la comparación se utilizó ANOVA.
Resultados. No hubo diferencias estadísticamente significativas ($p>0.05$)entre grupos tratados y grupos con placebo en cuanto a las medidas de altura de salto y potencia máxima en saltos con peso y sin peso. Tampoco hubo diferencias estadísticamente significativas ($p>0.05$) en la fuerza máxima ni en el ritmo de desarrollo de la fuerza con levantamientos isométricos de medio muslo.
Conclusión. Estos hallazgos indican que un suplemento de CHO+PROT en comparación con el placebo no aportó beneficios adicionales en levantadores entrenados durante un protocolo de bloques periódicos de 12 semanas.

PALABRAS CLAVE
Suplementos; levantamiento de peso; planificación en bloques

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Introduction

The sport of weightlifting consists of the snatch and the clean and jerk with the greatest weight lifted in each discipline giving an athlete a competition total. For weight class athletes such as weightlifters, body mass and composition have a large impact on performance.[1] It is advantageous for athletes to maximize the amount of lean body mass in relation to fat mass in order to lift the most weight in their respective class. One potential method to optimize sport performance and body composition is the use of nutritional countermeasures in the diet to offset the negative aspects of training and provide both enhanced recovery and adaption from the applied training stimulus.[2]

Nutrient timing manipulation involves the consumption of macronutrients around the workout window to facilitate recovery from training in the form of protein synthesis and glycogen repletion while mitigating the negative effects of catabolism that accompany training.[3] Several investigations on nutrient timing suggest that nutrient availability can serve as a potent modulator of many acute responses and chronic adaptations to both endurance and resistance-based training.[4] The primary macronutrients manipulated around the workout window are carbohydrate (CHO) and protein, which in appropriate doses can lead to an attenuation of protein degradation, an increase in protein synthesis and enhanced repletion of muscle glycogen post-training.[5] By combining CHO and protein ingestion following training, athletes can attempt to recover from isolated training bouts more efficiently due to potential synergistic effects.[3,5,6] The potentially additive effects of protein and CHO ingestion can be attributed to insulin stimulation, down regulation of catabolic hormones and activation of anabolic hormones.[3]

The consumption of amino acids following exercise stimulates protein synthesis and decreases protein breakdown.[7] Maximal stimulation of muscle protein synthesis has been shown to occur with consumption of ~6 grams of essential amino acids or ~20 grams of whole proteins in young, healthy populations.[5] Following resistance training there can be a shift towards a state of catabolism consisting of an imbalance in the rates of protein degradation and accretion leading to an altered nitrogen balance.[8] By incorporating both CHO and protein supplementation in conjunction with well-designed training may stimulate all the inputs of the anabolic pathways which could facilitate greater training adaptations. The ingestion of CHO serves dual roles by stimulating the release of insulin and causes increases in total protein accretion by diminishing protein breakdown.[9] The stimulation of insulin by CHO facilitates the absorption of nutrients at the cellular level and can lead to glycogen repletion by increased uptake of glucose by GLUT4 transport proteins.[10] A more catabolic state occurs following resistance exercise with glucagon, cortisol, epinephrine, and norepinephrine all upregulated to liberate energy needed to match training demands. The increase in insulin, insulin-like growth factor 1, growth hormone and testosterone following training leads to the diminishment of these catabolic hormones and the stimulation of anabolic pathways leading to glucose uptake and repletion as well as downregulation of protein degradation.[3]

The literature investigating the effects of protein supplementation on body composition and muscular strength has provided inconsistent results. [11,12] The discrepancies found can be attributed to subject variation, protein doses, methodology and various measurement techniques. It is important to note that to our knowledge, no studies exist to reporting any negative adaptations with protein consumption in conjunction with exercise training. CHO consumption following exercise has resulted in more consistent outcomes regarding performance, with post exercise consumption of carbohydrates being the most important factor in glycogen synthesis.[5] Combining CHO and protein and in conjunction with resistance training has been shown to stimulate improvements in strength and body composition when compared with control or placebo groups.[6]

Previous nutrient timing research has provided information primarily about untrained populations with relatively few incorporating well trained subjects [13,14] and to the authors knowledge no studies have been conducted employing a block periodization training model. Block periodization and appropriate programming has been shown to be efficacious and efficient for the increases in performance compared to other programs, particularly among athletic populations.[15-17] One might expect more efficacious programs coupled with supplementation to produce superior results in regards to athletic performance. Therefore, the primary purpose of this study was to examine the effects of a CHO and protein (CHO+prot) recovery beverage compared with a calorie free placebo on vertical jumps and isometric mid-thigh pull performance in trained weightlifters in a 12 week study utilizing block periodization.

Methods

Subjects

Ten trained weightlifters participated in this study and were randomly assigned to a treatment or a placebo group. Subject descriptive data can be seen in Table 1. Inclusion criteria required that each subject had been training regularly (minimum of 4 days a week) for weightlifting competition for a minimum of one year and free of orthopedic injury for the past 6 months. Each subject read and signed a written informed consent. This study was approved by the East Tennessee State University Institutional Review Board.

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Table 1: Subject Demographic Information Treatment

	Treatment		Placebo	
N	5		5	
Age (y)	28.4	±5.4	33.7	±3.2
Height (cm)	179.6	±4.5	175.2	±2.8
BM (kg)	95.3	±12.3	93.5	±15.3
Training Age(y)	5.2	±3.2	4.9	±3.4
EST1RM (kg)	170.6	±31.8	155.0	±38.9
EST 1RM STR/BW	1.8	±0.3	1.7	±0.3

Note: values are means± standard deviations, EST 1RM = Back squat 1 repetition maximum, EST 1RM STR/BW= ratio of back squat to body mass.

No athletes who had been training for less than a year on a periodized training protocol were admitted to this study. Only 10 subjects at our research facility met the criteria for inclusion into this study. All other athletes were either untrained, did not meet the training history criteria or had been injured in the past six months.

Experimental Design

A repeated measures design conducted in a double blind fashion was used to determine whether changes in static jumps, countermovement jumps and isometric mid-thigh were affected by a CHO+prot beverage. Prior to training, subjects were randomly assigned to either the treatment group or a placebo group. The treatment group received a ready to drink CHO+prot beverage immediately following each workout while the placebo group consumed a calorie free beverage at the same time point. The CHO+prot fruit punch flavored recovery beverage contained 230 calories consisting of 16 grams of hydrolyzed whey protein and 41 grams of carbohydrates consisting of sucrose and dextrose (Gatorade, Chicago, IL). The placebo group received an acaloric fruit punch drink (Great Value, Bentonville, AR). The supplement and placebo beverages were placed in opaque shaker bottles with subject numbers placed on the lid of the bottle to ensure anonymity. Subjects were instructed to consume no additional supplements during the study and to refrain from eating for 30 minutes following the consumption of the post workout beverage. Subjects were further instructed to maintain normal dietary practices and reminded consistently not to change their dietary habits over the course of the investigation. Each subject completed routine performance monitoring consisting of 4 jump testing sessions and 4 isometric mid-thigh pull testing sessions. The first testing session occurred before the intervention period and remainder of testing sessions were conducted the week following the conclusion of each training block.

Jump Testing Session

Prior to jump testing sessions each subject performed a standardized warm-up of 25 jumping jacks and10 body weight squats followed by a standardized back squat warm-up consisting of 5 repetitions with 40kg, 5 repetitions with 60kg and 5 repetitions of 80kg. Following this warm-up, 2 minutes of rest was provided before jump testing was initiated. Immediately following this rest period the subject completed a series of 10 jumps under 5 different weighted conditions with two trials at each weight and one minute of rest between each trial. The first two conditions tested were unweighted static and countermovement jumps using a near weightless PVC pipe held on the upper back in the back squat position. The remaining 3 conditions consisted of static jumps with 40kg, 60kg and 80kg respectively.

All jumps were performed on a dual force plate setup (2 separate 45.5 x91 cm force plates; RoughDeck HP, Rice Lake, WI) sampling at 1,000 Hz with subjects squatting down to a knee angle of 90˚, received a countdown and jumped as high as possible. Variables collected were jump height (JH) and peak power (PP) scaled to body mass for each weight: 0kg countermovement, 0kg static, 40kg static, 60kg static and 80kg static respectively.

Isometric Mid-Thigh Pull Testing Session

Prior to each Isometric mid-thigh pull testing session subjects performed a standardized warm up of 25 jumping jacks, 5 repetitions of barbell mid-thigh pulls with 20kg and 3 sets of 5 repetitions of barbell mid-thigh pulls with 60kg. Following the warm up, 2 minutes of rest were provided before initiation of the testing session. During this rest period, subject bar height was measured in the rack to assure a consistent knee angle of 125˚and hip angle of 145˚ using a goniometer. Subjects then performed two warm up trials with 50% and 75% of maximal effort with one minute of rest between each trial. After the second rest period subjects performed two maximal effort trials and were instructed to pull "as fast and as hard as you can" to ensure a maximum effort.[18] Testing for the isometric mid-thigh pull was performed on a dual force plate setup (2 separate 45.5 x91 cm force plates; RoughDeck HP, Rice Lake, WI) sampling at 1000Hz in a custom power-rack that allowed for adjustment of bar height and fixation at various heights. Only 100% trials were considered for analysis. Variables collected were peak force (PF) and rate of force development at 250ms(RFD@250).

Training plan

A 12-week periodized training plan was completed for this study. Four blocks were complted consisting of a strength endurance block (3 weeks), strength block (4weeks), power block (3 weeks) and a tapering and peaking block (2

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weeks). The block periodization protocol was utilized for the duration of this study consisting of four mesocycles, each containing 2-4 microcycles. Each subjects completed four training sessions per week consisting of general strength exercises, weightlifting movements and their weightlifting derivatives. Training session followed a Monday, Wednesday, Thursday, Saturday schedule for the duration of the study. A detail of the training plan implemented is contained in Table 2 and exercises implemented can be found in Table 3. Repetition maximums were determined based on sets and reps best system.[19]

Table 2: 12 Week Training Plan

Week	Sets x Reps	Daily Intensities (Mon, Wed, Thur, Sat)
1	3x10	M, M, L, L
2	3x10	MH, MH, ML, ML
3	3x10	H, H, L, VL
4	3x5(1x5)	ML, ML, L,VL
5	5x5	M, M, ML, ML
6	3x3(1x5)	MH, MH, VL, L
7	3x2(1x5)	ML, M, ML, L
8	5x5	H, MH, ML, L
9	3x3(1x5)	MH, M, L, L
10	3x2(1x5)	ML, L, VL, Meet
11	3x5	M, M, ML
12	3x5	L, L, VL

Note: Repetition maximums based on sets and reps best system. VL=very light, L= light, ML=medium light, M=medium, MH=medium heavy, H=heavy, Meet=competition day.

Table 3: Exercise Selection

Weeks	Exercises: Monday & Thursday	Wednesday	Saturday
1-3	BSQ	SN	SGS
	SP	CGS	SN
	DBP	CPP	SDL
		CDL	DBR
		DBR	
4-7	BSQ	SN	SGS
	PP	CGSS	SN
	BNP	CGBK	CJ
	DBP	CDL	SDL
		CGR	SGR
8-10	BSQ	SN	SGS
	JRK	CGS	SN
	DBP	SGP	CJ
		CDL	SDL
		DBR	DBR
11-12	BSQ	PS	
	DBP	CGS	COM
	FRR	CPP	
		SDL	
		DBR	

Note: COM=Competition, BSQ=Back Squat, JRK, Jerk, SP=Strict Press, PP=Push Press, BNP=behind the neck press, DBP= dumbbell press, FRR= front raise, CGS=clean grip shoulder shrug, SGS=snatch grip shoulder shrug, DBR= dumbbell row, CPP=clean grip pull from power position, CBK= clean grip pull from below the knee, SGP= Snatch grip pull from the floor, CDL= clean grip stiff leg deadlift, SDL= Snatch grip stiff leg deadlift, CGR= clean grip row, SGR= snatch grip, PS= power snatch, CJ= Clean and Jerk

Data and Statistical Analysis

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The countermovement jump, static jumps and isometric mid-thigh pull data were collected and analyzed using a customized LabVIEW program (2012 Version, National Instruments Co., Austin TX, USA). Voltage data obtained from the force plates was filtered using a digital low- pass Butterworth filter with a cutoff frequency of 10Hz in order to remove noise from the signal. Peak values of force and power were extracted from the force-time and power-time data, respectively, from each individual force plate.

Intraclass correlation coefficients (ICC) were used to determine the test-retest reliability of JH and scaled PP for jumps, PF, and RFD@250 for isometric pulls. A series of 2x4 (group x time) repeated measures ANOVA's were used to compare treatment and placebo groups for each jump condition and mid-thigh pulls. All statistical analyses were performed with SPSS 22 (IBM, New York, NY) and statistical significance for all analyses was set at $p \leq 0.05$.

Results

JH, scaled PP, PF and RFD@250ms displayed high test-retest reliability with ICC values of 0.99, 0.98, 0.95 and 0.76 respectively. Comparative data for jumps are displayed in figures 1 and 2 and data for isometric pulls are displayed in figures 3. No statistically significant ($p \leq 0.05$) main effect values were obtained for jumps for group by time. Statistical outputs for all jump conditions are detailed in table 4. No statistically significant ($p \leq 0.05$) group by time values were obtained for isometric mid-thigh pulls for PF ($F_{3,24}$=1.508, p=0.23) or RFD@250 ($F_{3,24}$=1.460, p=0.25).

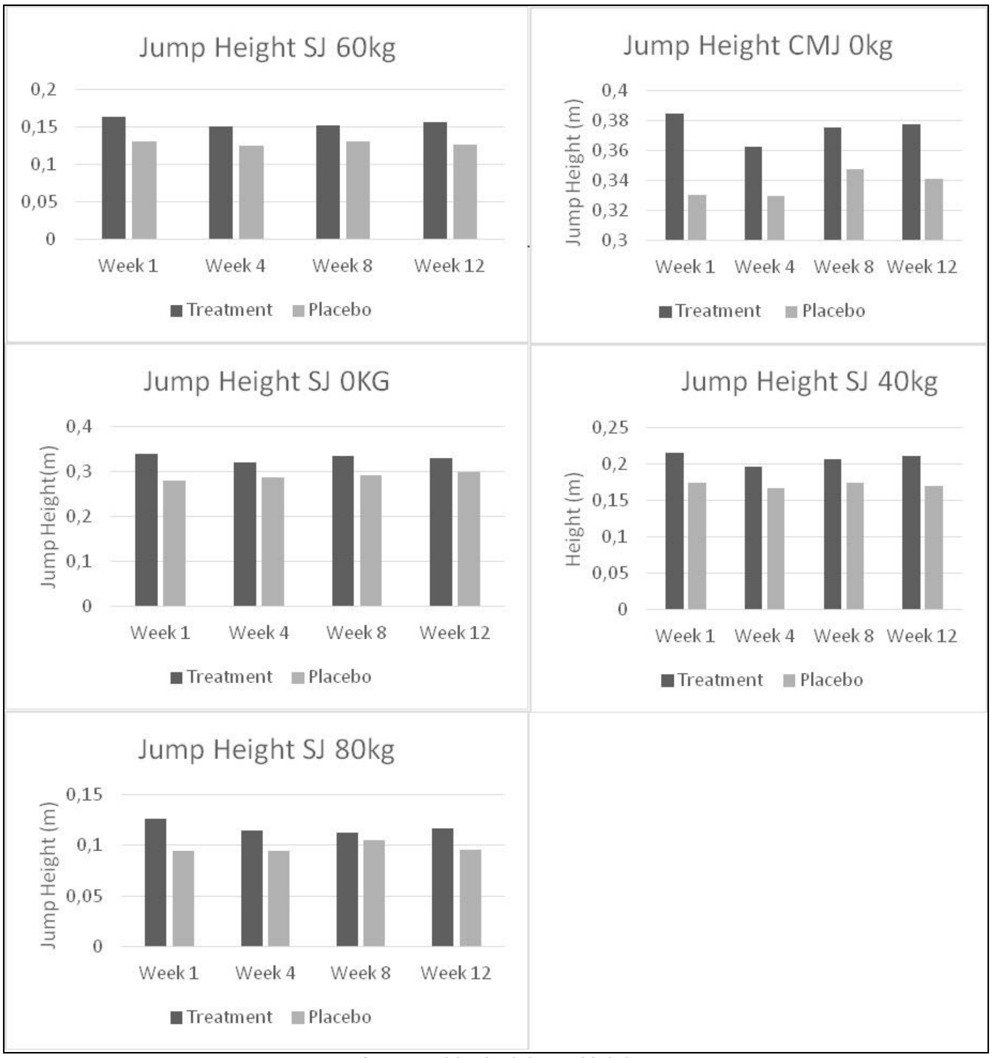

Figure 1: Vertical Jump Height

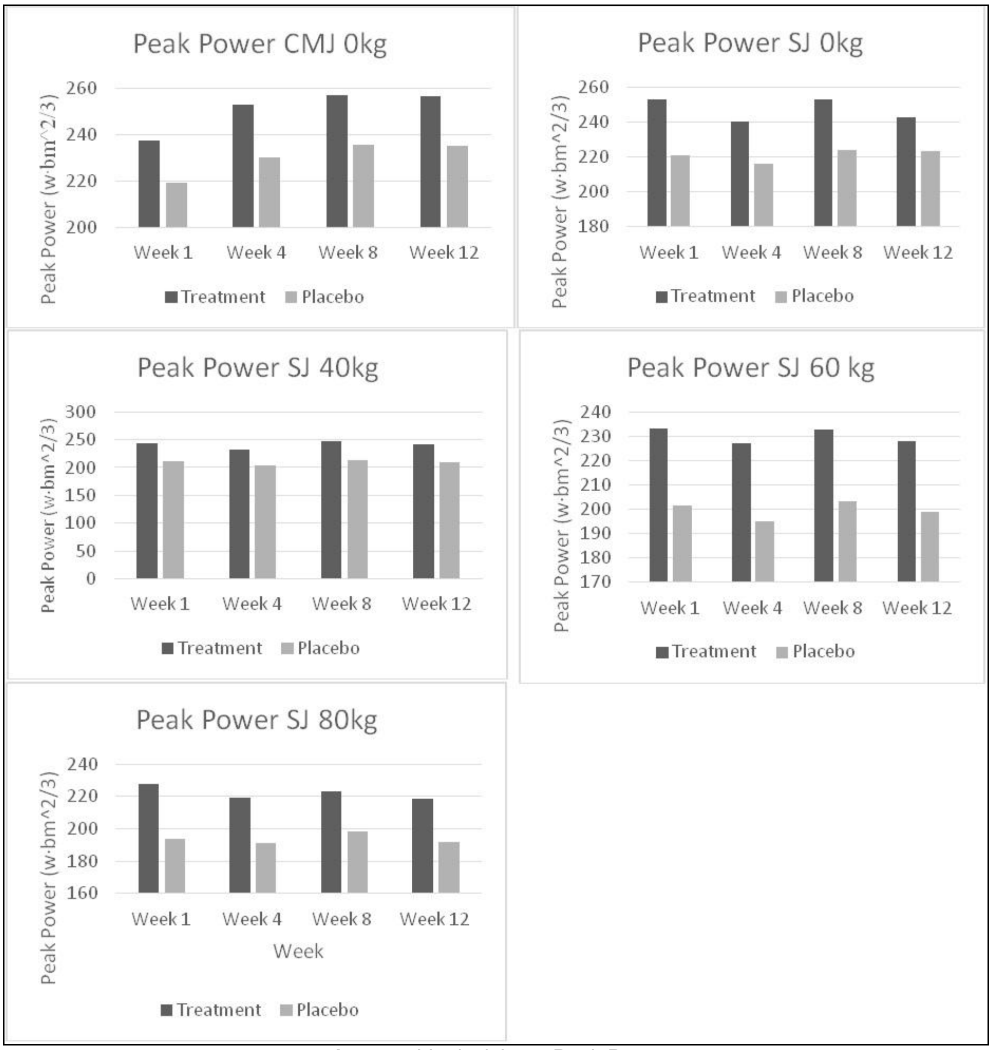

Figure 2: Vertical Jump Peak Power

Figure 3: Isometric RFD and Peak Force

Table 4: ANOVA Results for Jump height & Peak Power

Condition		df	error	F	*p*
Peak power:	CM0kg	3	24	.92	0.44
	SJ0kg	3	24	.80	0.50
	SJ40kg	3	24	.16	0.92
	SJ60kg	3	24	.08	0.96
	SJ80kg	3	24	.52	0.66
Jump Height:	CM0kg	3	24	.77	0.51
	SJ0kg	3	24	.89	0.45
	SJ40kg	3	24	.69	0.56
	SJ60kg	3	24	.42	0.73
	SJ80kg	3	24	1.74	0.18

Note: CM=countermovement jump, SJ=static jump

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Discussion

This study examined the effects of a CHO+prot supplement versus a placebo in trained weightlifters in a 12-week block periodization training protocol. The primary findings of this study were that no main effect or time differences occurred for JH or PP at any unweighted or weighted conditions as well as none for PF or RFD@250 for isometric mid-thigh pulls.

These finding are consistent with [12] who found a diminished protein supplementation effect occurring over a prolonged exposure stimulus after exercise training. The subjects in this study had a high training age and were currently trained prior to the intervention, which may explain the negated effect of the protein supplement on performance measures. However, findings from the present study are inconsistent with the work of [11] who have demonstrated strength effects from protein supplementation in both younger and older aged subjects. The subjects in this study had a high relative strength to body mass ratio before the training protocol which may explain the equivocal strength changes found in both groups from pre to post training. In two studies incorporating trained athletes by [13,14]the investigators report greater changes in 1RM strength for upper and lower body in trained athletes consuming a protein supplement compared to a placebo. These effects could not be replicated during this training protocol which employed a smaller sample size but better trained athletes than the previously mentioned studies.

There are a number of variables the authors believed would illuminate the use of recovery supplementation for athletes: 1) this training protocol used block periodization which incorporated heavy and light days in order to facilitate recovery and adaptation which is in contrast with previous studies that used progressive loading; 2) this study utilized trained subjects which would negate the learning effect of training which is often observed in untrained or minimally trained individuals; 3) this study implemented consistent monitoring techniques following each training block in an attempt to capture the adaptations that occurred within the training protocol 4) this study incorporated well trained subjects in both treatment and placebo groups who may be closer to their genetic ceiling.

There are several limitations to this study that should be considered when examining the data for conclusions: 1) no dietary recall was utilized for this study which attempted to preserve ecological validity; 2) these subjects were trained at the inception of this study and thus the stimulus of training and subsequent adaptation from training may be diminished due to previous training history. Over time athletes who train consistently find it progressively harder to adapt as an athlete approaches their genetic potential and thus the effect of the recovery supplement may be less effective due to the nature of diminishing returns of training protocols; 3) this study incorporated a training period of 12 weeks which is a short time span in order to investigate effects of training or supplementation which may have considerable residual training effects that may not manifest themselves until a later time point. Block periodization using phase potentiation capitalizes on the effects of previous training blocks to bolster performance at later time. The effects of this study may be magnified at later training blocks and due the short nature of this study did not measure any long term training effects; 4) the subject pool for this study was small which can increase the potential of finding no statistical changes due to the nature of small sample sizes. Because of the paucity of trained individuals, it is difficult to recruit and place trained athletes on the same training protocol.

Conclusion

In conclusion, the evidence does not appear to support the hypothesis that CHO+PRO supplementation would provide greater performance benefits than a placebo in trained weightlifters. Because training is an investment with current training manifesting itself as increased performance at a later date, further studies should be implemented utilizing nutrient timing and block periodization over the course of a macrocycle in order to access performance outcomes. Due to the limitations stated above subsequent studies should be conducted utilizing larger sample sizes of trained athletes as well as extending the duration of these studies to investigate long-term performance changes in athletes using nutrient timing as an ergogenic aid.

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Conflict of interest

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest in the subject matter discussed in this manuscript.

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