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Effects of a Carbohydrate-Protein-Creatine Supplement on Strength Performance and Body Composition in Recreationally Resistance Trained Young Men

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ABSTRACT

Cooper R, Naclerio F, Larumbe-Zabala E, Chassin L, Allgrove J, Jimenez A. Effects of a Carbohydrate-Protein-Creatine Supplement on Strength Performance and Body Composition in Recreationally Trained Young Men. **JEPonline** 2013;16(1):72-85. The purpose of this study was to analyze the effects of the commercially available multi-nutrient supplement "Cyclone" combined with a 12-wk progressive resistance training program (PRT) on body composition and strength performance in recreationally resistance trained (RRT) young adult males. Thirteen healthy male subjects were assigned to either a multi-nutrient formula Cyclone (CYC n=7) or a carbohydrate placebo (PL n=6). Both groups ingested CYC or PL in the morning and immediately after training. Before (T1) and after (T2) the 12 wks PRT; percentage body fat (%BF) and fat free mass (FFM) were determined. Maximum strength (1 RM) and repetitions to failure with 60% 1 RM (RTF60%) on bench press (BP) and parallel squat (SQ) were assessed. No significant increases in any of the performance or body composition variables were observed in either group. But, larger standardized effects sizes (ES) were observed for CYC compared to PL for 1 RM SQ (1.2 vs. 0.9); 1 RM BP (1.0 vs. 0.3); RTF60% SQ (1.1 vs. 0.2) and RTF60% BP (-0.3 vs. -0.09). Also, magnitude-based inferences demonstrated that CYC compared to PL was associated with a 78% likelihood of producing greater 1 RM BP improvements and 49% likelihood for greater improvements in RTF60% for both SQ and BP. Thus, the addition of CYC to a 12-wk PRT could be effective to potentiate upper body maximum strength or muscular endurance performance, but not body composition outcomes.

Key Words: Cyclone, Maximum Strength, Muscular Endurance

INTRODUCTION

Traditional nutritional interventions in athletes have focused on CHO, protein, amino acids, and other natural supplements such as creatine [24]. However, the more current literature has supported a combination of different nutrients as effective for improving performance [37,41]. While the positive effects from individual supplements such as whey protein (WP) [16,17], creatine monophosphate (CM) [5,39], carbohydrate (CHO) [33], beta-hydroxy-beta-methylbutyrate (HMB) [29,30] and to a lesser extent glutamine (GL) [24] on health and sports performance are generally supported, the effect of multi-nutrient products with specific combinations is not well documented. Also, research into the effects of nutritional supplements on the average gym user as opposed to a high performance or sports specific athlete would allow for a greater general application of the potential results.

Today, resistance training (RT) is one of the most popular physical activities recommended for people regardless of age. In fact, evidence exists to support the effectiveness of RT to improve strength, muscle mass, and physical performance (including daily living activities) [28]. Interestingly, only a few studies have examined the effects of a multi-nutrient supplements on the performance outcomes obtained from a high intensity RT programs. Cribb et al. [10] observed greater improvement on maximal strength, lean mass, fiber cross sectional area, and muscle contractile proteins after 10 wks of RT combined with a multi-nutrient CHO, WP, and CM compared to an equivalent dose of only WP or CHO. Schmitz et al. [34] observed greater significant improvements in strength, muscle endurance, and body composition in a group of young males when RT was combined with a multi-nutrient supplement (SOmaxP) rather than a similar supplement containing identical quantities of CM, WP, and CHO but lacking in other specific synergetic ingredients that are supposed to elicit positive synergistic affects to enhance training outcomes [34]. Meanwhile, Kraemer et al. [22] observed positive effects of a popular multi-nutrient supplement (Muscle Fuel) for improving strength and power, and performance while attenuating muscle damage and favoring a more desired anabolic hormonal environment after RT in young males [22].

Based on the research findings and the expert recommendations, supplement manufacturers have developed various multi-nutrient supplements combining WP, CM, CHO, and other anabolic or anti-catabolic agents (HMB and GL). These mixes should favor a more anabolic state of the body throughout the day and potentiate the benefits induced by RT workouts [8,22,40]. Aside from the convenience of having multiple ingredients in one product, there is potential for the components to exert additive or synergistic effects when combined [35,38]. To our knowledge no studies have assessed the effects of a multi-nutrient supplement providing >10 $g \cdot d^{-1}$ of CM combined with WP, CHO, HMB, and GL on strength performance and body composition in recreational RT practitioners. Therefore, the aim of this study was to analyze the effects of the commercially available multi-nutrient supplement “Cyclone” that consists of CM, CHO, WP, GL, and HMB on 12 wks of a progressive resistance training (PRT) program on body composition, strength, and muscular endurance in recreationally resistance trained (RRT) young adult males. We hypothesize that, in the RRT young males, the multi-nutrient supplement would provide greater RT outcomes and body composition benefits compared with an isocaloric carbohydrate placebo (PL).

METHODS

Subjects

Thirteen healthy RRT males (23.5 ± 2.7 yrs old, body mass (BM) = 80 ± 13 kg, height = 179 ± 6 cm) were randomized to receive either cyclone (CYC) or placebo (PL) in combination with a 12-wk PRT program (refer to Table 1).

Table 1. Baseline Mean and Standard Deviation Values for Age, Height, BM, %BF, and FFM in Both Groups.

Characteristics	CYC (n = 7)	PL (n = 6)
Age (yrs)	22 ± 1	26 ± 2
Height (cm)	178 ± 5	180 ± 8
% Fat	11.3 ± 5.4	18.4 ± 10.8
Fat free mass (kg)	64.9 ± 6.6	70.4 ± 5.3
Body mass (kg)	73.7 ± 11.4	87.3 ± 11.7

Key criteria used for the inclusion of the subjects were: (a) males; (b) 18-35 yrs of age; (c) regular recreationally RT for at least 2 yrs; (d) normal health history; (e) free from musculoskeletal limitations; and (f) fluent in English. Physical activity levels and health history were determined at baseline using standardized questionnaire [6].

Key criteria used for exclusion of the subjects were: (a) history of various metabolic conditions and/or diseases; (b) concomitant use of a variety of medications, including but not limited to those with androgenic and/or anabolic effects; (c) use of nutritional supplements known to improve strength and/or muscle mass such as creatine, HMB, whey protein, glutamine, dehydroepiandrosterone (DHEA) within 6 wks prior to the start of the study; (d) current use of tobacco products; and (e) the presence of any orthopedic limitations or injuries.

All participants agreed to comply with the RT and supplementation protocol and signed an informed consent. All experimental procedures were evaluated and approved by The University Institutional Review Boards for Human Participants.

Procedures

This study used a randomized, double-blinded, placebo-controlled parallel design. Since the subjects were recreationally experienced RT practitioners, only 2 days of familiarization with the testing procedures and minimal correction of exercise techniques were needed to minimize any potential learning effects with the assessment methodology. After familiarization, the subjects were randomly assigned to a supplementation group: (CYC; n = 7) or a placebo group (PL; n = 6). Before (T1) and after (T2) of the 12-wk PRT period, all the subjects' performance, body composition, maximal strength, and muscle endurance capabilities were assessed (Figure 1). The subjects were instructed to maintain the recommended dietary habits throughout the duration of the study.

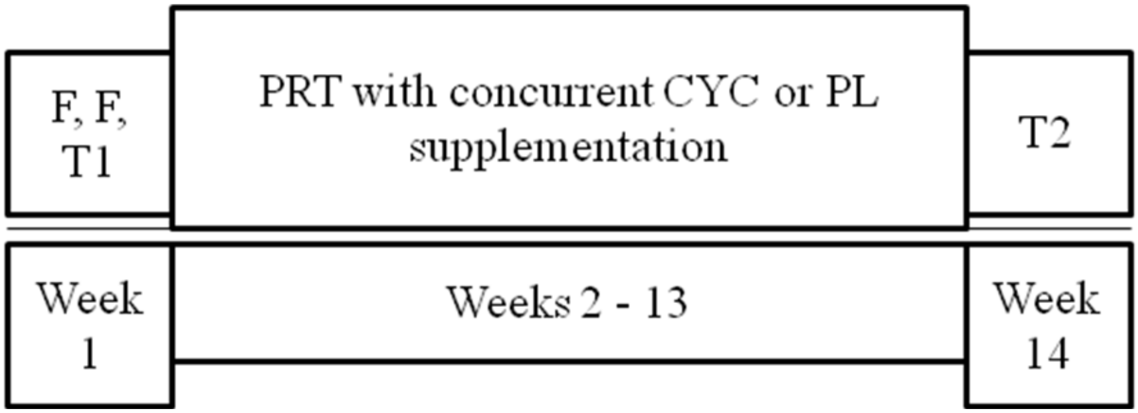

Figure 1. Schematic of Study Design.
F = Familiarization Period; T1: Pre-Assessment; T2: Post-Assessment

Testing Procedures

Prior to any testing session, the subjects were instructed to refrain from any vigorous activity for 48 hrs and avoid caffeine ingestion for at least 24 hrs.

Body Composition

Body mass (BM) and height were assessed, on a standard scale and standiometer according the methods described by Ross and Marfel-Jones [31].

Performance Test

The 1 RM and RTF60% tests were performed for both the bench press (BP) and the parallel squat (SQ) exercises. To minimize fatigue, the following assessment order was used: 1st 1 RM and 2nd RTF60%. To avoid any specific muscle group interaction, the order of testing for BP and SQ was randomized. All tests were carried out pre- and post-intervention at the same time of day specific to each subject. All testing sessions were started with a standardized, general warm-up of 3 to 5 min, which consisted of light dynamic flexibility exercise involving the muscle(s) to be tested.

Exercises

The BP and SQ exercises were performed using Olympic bars and plates [2]. For the BP exercise, the subjects had to maintain contact with the bench throughout the lift and perform each repetition with proper exercise technique. In order to standardize exercise technique for the SQ exercise, the subjects were instructed to maintain a shoulder width stance and descend until the thighs were parallel to the floor.

1 RM Test

The 1 RM test was determined according to methodology proposed by Baechle and colleagues [3]. In short, the subjects performed a specific warm-up set of 8 repetitions at ~50% of the perceived 1 RM followed by another set of 3 repetitions at ~75% of the perceived 1 RM. Subsequent lifts were single repetitions of progressively heavier weights until reaching the 1 RM. This process was repeated until a maximum of 5 attempts. If the subjects arrived at the 5th attempt, they were then asked to perform as many repetitions as possible. If more than 1 repetition was performed in the 5th attempt, the 1 RM value was calculated using the Brzycki equation [26]. The test-retest intra-class reliability for the two exercise test was $R > 0.93$ to < 0.98 ($P<0.001$).

RTF60%

Muscle endurance for the BP and the SQ exercises was measured as the total repetitions completed during a single bout of maximum repetitions to failure, using 60% of the previous determined 1 RM. All subjects were required to perform repetitions with correct form until voluntary exhaustion or failure of exercise form [18].

Body Composition Assessments

Body composition was assessed by whole body densitometry using air displacement via the Bod Pod® (Life Measurements, Concord, CA). All testing was done in accordance with the manufacturer's instructions as detailed elsewhere [12]. Briefly, the subjects were tested wearing only tight fitting clothing (swimsuit or undergarments) and an acrylic swim cap. The participants wore the exact same clothing for all testing. Thoracic gas volume was estimated for all subjects using a predictive equation integral to the Bod Pod® software. The calculated value for body density was used in the Siri equation [36] to estimate body composition. A complete body composition measurement was performed twice. If the %BF was within 0.05%, the 2 tests were averaged. If the 2 tests were not within the 0.05% agreement, a 3rd test was performed and, then, the average of 3 complete trials was used for all body composition variables.

Dietary (Nutrition) Monitoring

A research nutritionist collected dietary habits and explained the proper procedures for recording dietary intake. Each subject's baseline diet (3 days, 2 weekdays, and 1 weekend day) was analyzed using Dietplan 6 software to determine its energy and macronutrient content. In order to guarantee an adequate macronutrient intake throughout the 12-wk study intervention, a standardized nutritional procedure was given to each subject. According to the American Colleges Sports Medicine [1] and the International Society of Sports Nutrition recommendation [7] and in order to favor optimal outcomes from the RT program, 1.5 to 2 $kg{\cdot}d^{-1}$ of protein, 5 to 6 g of CHO $kg{\cdot}d^{-1}$ along with 25% to 30% of total caloric intake from fats had to be provided by the diets.

Resistance Training

All subjects were placed on a 4 $d{\cdot}wk^{-1}$ upper/lower split PRT program that incorporated all the muscle groups for 12 wks (refer to Table 2).

Table 2. Training Schedule.

Day	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
Training	UB	LB	Rest	UB	LB	Rest	Rest

UB = Upper body exercises; LB = Lower body exercises

Training methods were standardized, again to eliminate as many confounding variables as possible. A progressive, 12-wk, hypertrophy, split training program (4 set per exercise of 6 to 12 repetition with 65 to 80% 1 RM range and 2 min rest between sets) was designed based on previously published findings [27,28]. The upper body (UB) and lower body (LB) routines were organized as follows:

- UB: Bench press; Bent over row; Shoulder press, Bicep curls, and Triceps extension
- LB: Squat, Stiff leg deadlift, Lunges, and Dynamic upright row

The exercise regime was based upon each subject's 1 RM for BP and SQ: 1st set of 12 repetitions with 65% 1 RM; 2nd set of 10 repetitions with 70% 1 RM; 3rd set of 8 repetitions with 75% 1 RM, and 4th set of 6 repetitions with 80% 1 RM. The weight for the remaining exercises was adjusted, based on the subjects' resistance training experience, to allow for the required number of repetitions per set. Good form and technique had to be maintained at all times and with the exception of the 4th set, no failure achievement was allowed. As the subjects perceived performance improvements, in order to maintain training stimulus, weight was added at 2.5% or 5% increments for the upper and lower body, respectively.

Supplementation Protocol

The caloric values and nutrient compositions of the CYC and PL supplements are listed in Table 3. On each of the testing and training days the participants ingested the CYC or PL twice per day: one serving (60 g) with 350 to 400 mL of water at breakfast and another immediately (within 15 min) after the workout. On non-training days, the second intake was ingested in the afternoon at approximate the same hour of training.

Table 3. Nutritional Composition for CYC or PL.

	CYC 60 g serving		PL 60 g serving
Total Energy	230 kcal	Total energy	228 kcal
Protein	30 g	Protein	0 g
Carbohydrate	21 g	Carbohydrate	56 g
Total Fat	4.68 g	(maltodextrin)	
		Total Fat	0 g
Creatine Monohydrate	5.1 g		
Glutamine	5.1 g		
HMB	1.5 g		
Potassium Bicarbonate	500 mg		
Sodium Bicarbonate	500 mg		
Bioperine	5 mg		
Chromium Picolinate	241 µg		

The PL supplement was virtually indistinguishable from the CYC supplement in taste, color, and consistency. Both the CYC and PL supplements were prepared in powder form and packaged in coded generic sachets for double-blind administration by an independent company (Maximnutrition). Compliance to the supplementation protocol was monitored by a researcher who contacted the study subjects on a weekly basis. All subjects were required to bring in their supplement sachets on the 6th-wk and the 12th-wk for visual inspection by study personnel to assess compliance with the research protocol.

Statistical Analyses

Data normality of distribution for each group was assessed using the Shapiro-Wilk test and scrutinizing the Q-Q plots. Series of factorial ANOVA, (2 × 2; time [pre- vs. post-training] × group [CYC vs. PL]) were employed. The repeated measures were the pre- and post-treatment, and the treatment groups were CYC and PL. For all variables tested with the 2 x 2 factorial ANOVA, equality of covariance was checked with the box test of equality of covariance matrices while Leven's test was used to ascertain equality of variances.

Standardized effect sizes (ES) were calculated to determine the magnitude of an effect independent of sample size. Cohen´s effect sizes (*d*) were measured by the formula: [Cohen´s $d = M_2 - M_1/s$]. *Small* effect sizes are considered $d \leq 0.2$, *moderate* effect sizes are $0.2 < d < 0.8$, and *large* effects sizes are $d \geq 0.8$. A multivariate analysis of effects was performed for the different treatment groups on all the dependent variables.

In addition to the use of statistical significance and standardized effect sizes, magnitude based inferences were used to determine the practical significance of 1 RM BP, 1 RM SQ, RTF60%, BP and RTF60% SQ performance. Using a Microsoft Excel spreadsheet designed for sports science research [15], mean effects and the 90% confidence limits were estimated to establish the percentage likelihood of each experimental condition having a positive/trivial/negative effect on performance. The smallest worthwhile improvement for 1 RM and RTF60% for both BP and SQ was considered to be an increase equivalent to 0.2 between subject standardized ES established from baseline performance [14], which were 2.2 kg (2.4%) and 4.1 kg (3.3%) for 1 RM BP and 1 RM SQ and 1.6 (7.5%) repetitions and 0.9 (4.0%) for BP RTF60% and SQ RTF60%, respectively. IBM SPSS Statistics software (version 19) was used to conduct the statistical analysis

RESULTS

Table 4 and Table 5 show the mean and standard deviation values for the body composition and performance variables, respectively.

Table 4. Mean and Standard Deviation Body Composition Values Measured Before (T1) and After (T2) the Training Period.

Variable	Body Composition			
	%BF		FFM	
Group	T1	T2	T1	T2
CYC	11.3 ± 5.4	13.2 ± 5.1	64.9 ± 6.6	66.9 ± 7.4
PL	18.4 ± 10.8	18.5 ± 10.4	70.4 ± 5.3	71.1 ± 5.7

Table 5. Mean and Standard Deviation Strength Related Performance Values Measured Before (T1) and After (T2) the Training Period.

Exercise	BP				SQ			
Test	1 RM (kg)		RTF60%		1 RM (kg)		RTF60%	
Group	CYC	PL	CYC	PL	CYC	PL	CYC	PL
	(n=7)	(n=6)	(n=7)	(n=6)	(n=7)	(n=6)	(n=7)	(n=6)
T1	87.6	96.2	104.7	20	111.3	137	22	22
	± 16	± 30	± 24.2	± 2	± 33.2	± 43.5	± 8	± 9
T2	103.9	104.7	17	18	149.9	177	31	29
	± 22.3	±24.2	± 3	± 3	± 49.4	± 46.4	± 11	± 15

*P<0.05

Independent samples *t* test were conducted to compare BM, height, %BF, and fat free mass (FFM). No statistical differences were observed at baseline for any of the variables (P>0.05). A main effect for time interaction was observed for BM ($F_{(1,11)}$=14.98, P<0.005, η^2=<0.577). The interaction between time and group was also significant ($F_{(1,11)}$=5.75, P<0.05, η^2=<0.343). However, no significant interaction effects was observed between the groups ($F_{(1,11)}$=3.56, P>0.05, η^2=0.245). The same approach was adopted in the analysis of the %BF and FFM. The time main effect was significant for FFM ($F_{(1,11)}$=7.60, P<0.05, η^2=0.409), but not for %BF ($F_{(1,11)}$=3.42, P>0.05, η^2=0.237). The group by time interaction and the group main effects were not significant for %BF ($F_{(1,11)}$=2.78, P>0.05), η^2=0.201), ($F_{(1,11)}$=1.90, P>0.05, η^2=0.147), respectively, and FFM ($F_{(1,11)}$=1.91, P>0.05, η^2=0.148), ($F_{(1,11)}$=1.90, P>0.05, η^2=0.147).

There was a significant time effect for 1 RM BP (F(1,11)=16.99, P<0.05, η^2=0.611); 1 RM SQ (F(1,11)=46.20, P<0.001, η^2=0.81) and SQ RTF60% ($F_{(1,11)}$=9.41, P<0.05, η^2=0.46). However, no significant effects for time interaction was observed for BP RTF60% ($F_{(1,11)}$=1.315, P>0.05, η^2=0.107). No significant differences were observed between CYC and PL for any of the performance variables. No group differences have been detected for 1 RM BP ($F_{(1,11)}$=0.14, P>0.05, η^2=0.01), 1 RM SQ ($F_{(1,11)}$=0.22, P>0.05, η^2=0.02) RTF60% BP ($F_{(1,11)}$=1.32, P>0.05, η^2=0.11) or RTF60% SQ ($F_{(1,11)}$=0.02, P>0.05, η^2=0.002)

There were no significant differences in dietary intake for the participants in either cohort, based on dietary diary evaluation (P>0.05). Dietary protein contents were between the expected range of >1.5 to 2.0 $g \cdot kg^{-1} \cdot BM$ for all of the participants regardless of the group.

The Standardized ES analysis revealed large values for CYC in 1 RM BP (1); 1 RM SQ (1.2) and RTF60% SQ (1.1) while for the PL group only for 1 RM SQ (0.9). Moderate ES were observed for CYC in FFM (0.3). The PL group showed moderate ES for 1 RM BP (0.3) and RTF60% SQ (0.7) (Figure 2). Inherently both groups showed a non-significant negative change in BP RTF 60%, but with larger ES in PL (-0.9) compared to CYC (-0.3).

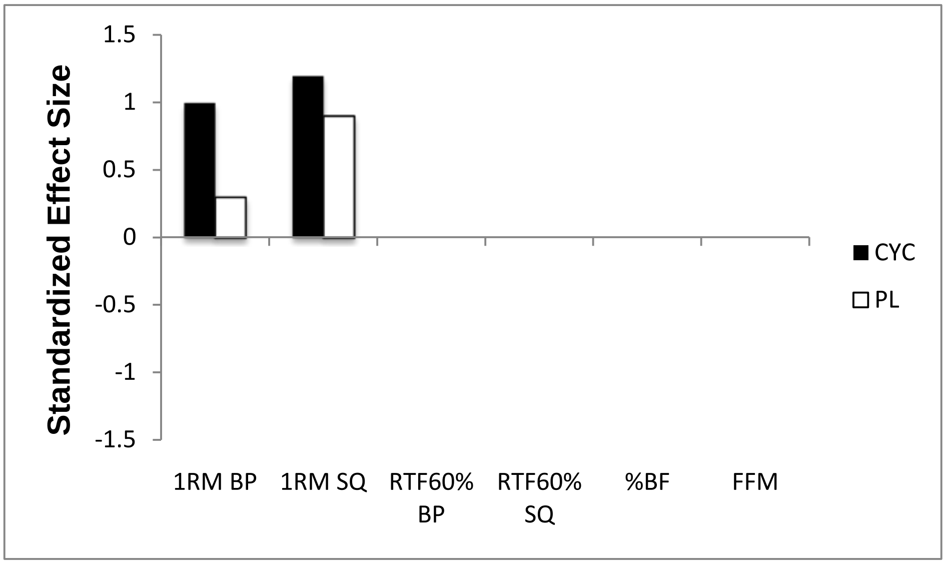

Figure 2. Comparison Between the Standardized Effect Sizes Calculated for CYC and Pl Group for the Six Analyzed Variables in the Study.

Table 6 compares the performance improvements of CYC to the PL and the percentage likelihood of CYC having beneficial/trivial/negative effects. The CYC was associated with a 78%, 49%, and 49% likelihood of producing performance benefits compared to PL for 1 RM BP, RTF60% BP, and RTF60% SQ, respectively. However, CYC seems less effective than PL for improving 1 RM SQ.

Table 6. The Change in 1 RM and RTF60% Performance Determined in CYC Group from the Baseline Relative to the Changes Measured in PL Group from Baseline.

Δ CYC - Δ PL: Raw Difference ±90% Confidence Limits		Magnitude-Based Inferences: Likelihood of CYC Compared with PL of Being		
		Positive	Trivial	Negative
1 RM BP (kg)	7.79 ± 11.1	78 likely	20 unlikely	2 Very unlikely
1 RM SQ (kg)	-1.43 ± 20.6	31 possibly	28 possibly	41 possibly
RTF60% BP (reps)	0.86 ± 4.7	49 possibly	26 possibly	25 possibly
RTF60% SQ (reps)	1.62 ± 8.4	49 possibly	26 possibly	25 possibly

DISCUSSION

The results of the present study show that both groups increased total BM and FFM as well as 1 RM and RTF60% regardless of the treatment. However, no significant differences ($P<0.05$) were observed between groups for body composition or performance related variables. As shown by the standardized effects sizes (ES) values, training outcomes achieved at T2 a trend to be more favorable for CYC compared to PL (Figure 2). Additionally, magnitude based inferences suggest that in recreationally trained males, combining a multi-nutrient supplement containing CM, WP, CHO, GL and HMB was 78% likely to improve upper body maximal strength, with 2% likelihood of a negative effect, when compared to PL. The same trend was observed for upper and lower body muscular endurance tests where CYC showed a 49% possibility to improve performance with a 25% chance of producing negative effects in respect to PL.

The larger standardized ES for FFM, 1 RM BP and RTF60% SQ were consistent with the results reported by other studies. Cribb et al. [9] examined the effects of a WP-CHO supplement containing 0.1 $kg \cdot d^{-1}$ of CM compared to the same amount of WP-CHO supplement (without CM) during 10 wks of RT in recreational male bodybuilders. Although both supplements were similar in energy and nitrogen content, the group that received CM demonstrated greater gains in 1 RM strength, lean body mass, fiber cross sectional area, and contractile protein content. In a similar study, Cribb et al. [11] observed greater maximal strength and hypertrophy responses when a 11-wk RT program was combined with a CHO, WP, and CM supplement compared to a CHO supplement.

In spite of the fact that CYC supplementation did not show a significant effect on 1 RM SQ or 1 RM BP, a main effect for time was significant for both 1 RM BP and 1 RM SQ. This demonstrates the efficacy of the RT intervention alone. However, the lack of significance due to CYC supplementation does not mean the supplement was ineffective. In fact, CYC showed a 78% likelihood of being of greater benefit than PL for improving 1 RM BP. Although speculative, but based on the ES and magnitude based inferences analysis, the small sample size ($n = 13$) could have affected these results. Moreover, given that the sample consisted of RRT practitioners, it is possible that the training alone may elicit larger performance outcomes compared to training with CYC [21]. Also, as pointed out in previous studies [4,23,39], high doses of CM supplementation alone or in combination with CHO and protein, as administered in the present study (~10 $g \cdot d^{-1}$), have shown significant and positive effects for improving strength performance and FFM in practitioners of RRT.

In addition to the small sample size, another reason that may have influenced the lack statistical significance of CYC effect could be assigned to the supplementation protocol. The present study analyzed the efficacy of the protocol suggested by the manufacturer: 1 intake at breakfast and other immediately after training. This protocol is different from others applied in previous studies, where significant improvements in strength and body composition have been observed after consuming the supplements just prior to and immediately after the workout [8,9]. The International Society of Sports Nutrition suggests that the ingestion of WP, CHO, and CM after a workout may potentiate expected adaptations to RT. It is also stated that pre-exercise ingestion of CHO and protein may result in peak increases of protein synthesis [20]. In the present study, FFM showed a slight trend for a greater increase in the supplemented group.

Supplementation with HMB has been suggested to increase protein synthesis [42]. However, the alleged benefits of HMB supplementation appear to have conflicting evidences. A recent meta-analysis [32] concluded that HMB supplementation has: (a) small to a negligible effect on strength depending on the experience of the weightlifter; and (b) trivial effect on body composition in both untrained and trained weightlifters. The average intervention time from the meta-analysis was 5 ± 2 wks, which may not be enough time for trained subjects to experience the effects from HMB supplementation. It is presumed that HMB works through anti-catabolic action and attenuation of muscle damage [32]. Therefore, a training program would have to stress the subject sufficiently to increase activity and/or intensity of the current program in order to potentially benefit from the supplementation of HMB [13]. It is believed that the RT program in the present study was of sufficient duration and intensity to benefit from HMB supplementation [32]. The combination of HMB and creatine, as used in our study, has been shown to mediate greater increases in strength and FFM than HMB supplementation alone through additive effect [19]. This may have mediated the larger ES for 1 RM observed in this study. Speculation on HMB supplementation, especially in athletes, should be treated with caution as further research is needed before conclusions can be drawn [24].

Supplementation with GL is well-tolerated, even in amounts up to 0.65 $g \cdot kg^{-1}$ of body mass. However, there is not enough evidence to recommend the use of GL as an effective supplement for improving body composition and strength performance [25]. For RTF60% BP both groups showed a trend to reduce performance, but CYC experienced less of a decrease compared to PL. This was possibly due to the RT program having more emphasis on the lower body and less emphasis on the upper body than the RRT subjects were accustomed to. The use of CYC would seem to attenuate this decrease in performance. In fact, the likelihood of CYC being of benefit to upper body muscular endurance compared to PL was 49% with a 25% possibility of being harmful.

Additional research with a larger sample size is needed to further the understanding of the effects of combined multi-nutrient supplements and RT on strength performance and body composition.

CONCLUSIONS

Based on the observed ES and magnitude based inferences analysis, it seems reasonable to conclude that combining a PRT program with the ingestion of a natural multi-nutrient supplement such as CYC may be more effective than a maltodextrin placebo compound to potentiate the expected performance outcomes from a 12-wk progressive hypertrophy RT program.

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