Original Research

The Effects of a Commercial, Pre-exercise Energy Drink Supplement on Power, Muscular Endurance, and Repeated Sprint Speed.

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ABSTRACT

International Journal of Exercise Science 9(2): 205-213, 2016. The purpose of this study was to investigate the effects of ingesting a pre-workout commercial energy drink supplement on multiple parameters of physical performance, including upper body and trunk muscular endurance, muscular power, and repeated sprint speed. 19 college-aged males (n = 8) and females (n = 11) participated in this randomized, double-blind, parallel groups study. At baseline and post-testing (about one week after baseline testing), anaerobic power (assessed via a countermovement vertical jump), muscular endurance (assessed via YMCA bench press test and a curl-up test), and repeated sprint speed were assessed. Thirty minutes prior to post-testing, subjects ingested one serving (1.75 ounces [37 ml]) of a calorie-free, caffeine-containing pre-exercise energy supplement (Redline Power Rush by VPX) (n = 10) or an isovolumetric and similar tasting placebo beverage (n = 9). While vertical jump, YMCA bench press, and repeated sprint speed improved from pre to post testing in both treatment groups, there were no differences between the energy drink and placebo beverages. Curl-up endurance performance improved following the energy drink ingestion but did not improve following placebo ingestion. However, this observation also failed to reach statistical significance (p = 0.120). A possible explanation for the lack of effect of the pre-exercise energy drink to enhance physical performance was the relatively low amount of caffeine that was present in the beverage (providing an average of 2.4 mg caffeine/kg body mass).

KEY WORDS: Sports nutrition, pre-workout supplementation, exercise performance, dietary supplement, resistance exercise,

INTRODUCTION

Consumption of caffeine-containing liquid energy supplements (i.e., energy drinks) has increased dramatically over the past several years. It has been reported that energy drinks are the most popular dietary supplement besides multivitamins in the American young adult population (12, 16). One of the primary reasons for ingesting energy drinks is for the purpose of enhancing workouts, improving sports performance, and to facilitate faster training adaptations (23).

The main ingredients in most commercially available energy drinks are caffeine, carbohydrates, B vitamins, taurine, herbs, and other flavorings. Of these ingredients, caffeine and carbohydrate are the primary ergogenic nutrients in energy drinks (4). According to the International Society of Sports Nutrition, ingestion of 3-6 mg of caffeine per kilogram of body mass is recommended for enhancing exercise performance (13). Despite this threshold for caffeine to improve exercise performance, enhancements in aerobic (19, 24) and resistance exercise (8, 11, 14) performance have been reported with lower levels of caffeine present in the energy drink – amounts containing approximately 2 mg/kg. However, it is important to note that the improvements in exercise performance that were observed with lower than recommended doses of caffeine were observed with additional ingredients combined with caffeine. It may be that improvements in exercise performance with lower than recommended amounts of caffeine (2 mg/kg rather than 3-6 mg/kg) are caused by the potential synergism of the various ingredients (in addition to caffeine) contained in energy drinks.

In contrast to those investigations reporting improvements in exercise performance following energy drink ingestion, other investigations have not reported favorable outcomes. Specifically, no improvements in performance were reported for anaerobic (11, 18) or high intensity aerobic (5, 21) exercise following energy drink ingestion. Reasons for the equivocal findings in relation to energy drink ingestion may be attributed to differences in caffeine content and the other added ingredients. In addition, differences in the timing of ingestion of the pre-workout energy drinks was also varied across studies. Because of the equivocal findings in this area, more research is needed to elucidate the true effectiveness (or non-effectiveness) of pre-workout energy drink ingestion and its effects on exercise performance.

Given the diversity of outcomes with pre-workout energy drink ingestion, the purpose of this study was to investigate the effects of ingesting a non-caloric pre-workout commercial energy drink supplement on multiple parameters of physical performance, including upper body and trunk muscular endurance, muscular power, and repeated sprint speed in healthy, college-aged students.

METHODS

Participants

Participants included nineteen college-aged males (n = 8) and females (n = 11). Participant demographics were as follows: age = 22.4 ± 3.2 years; body mass = 69.0 ± 12.7 kg; BMI = 23.9 ± 2.9; and height = 168.7 cm. Inclusion criteria stated that all participants be in good health and be without any medical issues at the time of testing. Health of the participants was assessed and confirmed by use of a medical history questionnaire and PAR-Q. All participants were informed of the procedures and associated risk associated with this study before testing, and each signed an informed consent stating they understood these risks and agreed to voluntarily participate. The study design included a randomized, double-blind, placebo controlled, repeated measures parallel design.

Protocol

The protocol utilized in this research was approved by a university Institutional Review Board prior to commencement of the study. A test-retest design was used to determine the effectiveness of a pre-workout energy drink supplement on several parameters of physical performance. Prior to baseline and post-testing, participants were asked to abstain from caffeine and strenuous activity for 12 hours. Additionally, they were asked to fast for 2 hours prior to testing. Each participant was interviewed before testing to ensure these standards had been met. The two testing sessions were performed 48 hours apart. At baseline and post-testing, anaerobic power, muscular endurance, and sprint speed were assessed. Thirty minutes prior to post-testing, subjects ingested one serving (1.75 ounces [37 ml]) of the pre-exercise energy supplement (Redline Power Rush by VPX™) (n = 10) or a placebo beverage (n = 9). Administration of the supplement was randomized and double blind. Performance outcome variables were assessed at baseline and post-testing and included the following tests in this sequence: countermovement vertical jump, YMCA bench press test, curl-up test, and repeated sprint speed. One of the reasons these specific tests were utilized is because similar tests have been utilized in recent studies in which pre-workout energy drink ingestion was investigated (6-11).

Vertical jump height was obtained via a Just Jump System (ProBotics Inc., Huntsville, Al). All subjects were instructed to step on the jump mat and when ready, perform a maximal jump with a countermovement arm swing, which was used to determine vertical jump height. The best of three attempts was recorded.

Upper-body muscular endurance was tested via the YMCA Bench-Press test (2). The YMCA bench press test involved the performance of standardized bench presses at a rate of 30 repetitions per minute. Males were tested using a 36.3kg barbell and females used a 15.9 kg barbell. The participant positioned themselves on the bench in the supine position, with legs bent at the knee and feet flat on the floor. The participant gripped the bar with arms and hands shoulder width apart and pressed the barbell and weight upward to fully extend the arms. After each lift the participant returned the barbell to the original position. Each participant was asked to complete as many repetitions as possible keeping a consistent pace of 30 reps per minute (rhythm was monitored with the use of a metronome). The test was terminated when the rhythm was broken or the participant failed to reach full extension. Scores for this test equaled the number of successful repetitions completed (2).

Trunk muscular endurance was collected via the curl-up test. The technique used for this test adhered to the U.S. Navy's Physical Readiness Test (20). Participants were instructed to lie on their back with their knees bent, heels flat on the ground and 25.4 cm from the buttocks, with their arms folded across and touching chest with hands touching upper chest or shoulders, and a partner anchoring them to the ground by holding their feet. The participants were then instructed to curl the body up, touching the elbows to thighs while keeping hands in contact with the chest or shoulders. After touching elbows to thighs, the participant lied back, touching the lower edge of the shoulder blades to the ground. Participants were instructed to perform as many correct sit-ups/curl-ups as possible in two minutes.

Repeated sprint speed was measured using ten, 20-meter sprints performed consecutively with 10 seconds rest between sprints. The Smartspeed™ (Fusion Sport, Australia) was utilized to time the sprints. Stopwatches were used to time the 10-second rest intervals between sprints. Sprint times were averaged across all 10 sprints and were recorded and analyzed.

Prior to the second testing session participants were randomly assigned to ingest the calorie-free energy drink (Redline Power Rush by VPX™) or placebo beverage (isovolumetric and similar in taste to the energy drink beverage). Ingredients for the energy drink are listed in Table 1. The non-caloric energy drink treatment contained both the medicinal (active) ingredients and non-medicinal (inactive) ingredients. The placebo beverage contained only the non-medicinal ingredients. Both the non-caloric energy drink and the placebo groups ingested 1.75 ounces (37mL) of liquid. Approximately 30-minutes post consumption, the participants completed the same assessments in the same order as was completed at baseline. Prior studies utilizing carbohydrate-free pre-workout energy drinks (similar to the non-caloric energy drink used in the present study in relation to the absence of carbohydrate) used a range of 10-minutes to 60-mintues ingestion points prior to exercise performance (5, 24). Using these prior investigations as a guide, the present study chose an ingestion time point that was approximately mid-range – thirty minutes prior to the subsequent assessment period.

Statistical Analysis

Baseline differences between groups were analyzed via an independent samples t-test.

Table 1. Medicinal and non-medicinal ingredients contained in the treatment beverages.

Medicinal Ingredients (Energy Drink Treatment Only)	Non-medicinal Ingredients (Energy Drink &Placebo Treatments)
Vitamin C (60 mg)	Highly Purified Water
Niacin (5 mg)	Malic Acid
Vitamin B12 (0.0625 mg)	Phosphoric Acid
Vitamin B6 (0.75 mg)	Natural Red Color
Folic Acid (0.2 mg)	Sucralean® (Sucralose)
Caffeine Anhydrous (175 mg)	Potasssium Sorbale
N-Acetyl-L-Tyrosine (125 mg)	Potassium Phophate Dibasic Glycerin
Beta-Alanine (12.5 mg)	Disodium EDTA
DL-Phenylalanine (0.325 mg)	Sodium Benzolate
L-Phenylalanine (0.325 mg)	Natural Fruit Punch Flavours

Pre-posttest differences over time were analyzed via a 2-factor [2x2] between-subjects repeated measures analysis of variance (ANOVA) using Statistical Packages of the Social Sciences (SPSS) version 22.0 software (Chicago, IL). The energy drink and placebo beverage treatments were the independent variables. Dependent variables were vertical jump, YMCA bench press, curl-up test, and sprint test scores. The criterion for statistical significance was set a priori at $p \leq 0.05$.

RESULTS

There were no differences observed between the non-caloric energy drink group and the placebo group at baseline for vertical jump, curl-up to fatigue, and average sprint time. In contrast, a significant difference ($p = 0.01$) was observed for the YMCA bench press test at baseline.

There were no group x time interaction effects (p = 0.92) nor main effects for time (p = 0.56) observed for vertical jump. Vertical jump improved from 47.5 ± 11.8 to 47.9 ± 10.9 cm (an improvement of 0.8%) and from 46.3 ± 15.2 to 46.8 ± 15.3 cm (an improvement of 1.0%) in the non-caloric energy drink and placebo treatments, respectively.

Similarly, there were no group x time interaction effects (p = 0.97) nor main effects for time (p = 0.24) observed for YMCA bench press scores. Bench press improved from 40.8 ± 8.9 to 43.2 ± 12.9 repetitions (an improvement of 5.9%) and from 29.4 ± 8.5 to 32.0 ± 10.3 repetitions (an improvement of 8.8%) in the non-caloric energy drink and placebo treatments, respectively.

Curl-up performance improved following non-caloric energy drink treatment as compared to the placebo treatment. Curl-up performance improved by approximately 21% and decreased by approximately 15% in the non-caloric energy drink and placebo treatments, respectively (Figure 1). Despite the different outcomes in curl-up performance between the groups, no group x time interaction was observed (p = 0.120).

Lastly, there was no group x time interaction effects (p = 0.58) nor main effects for time (p = 0.28) observed for sprint speed. Average sprint speed times improved from 4.01 ± 0.30 to 3.95 ± 12.9 seconds (an improvement of 1.5%) and from 4.14 ± 0.73 to 3.97 ± 0.58 seconds (an improvement of 4%) in the non-caloric energy drink and placebo treatments, respectively.

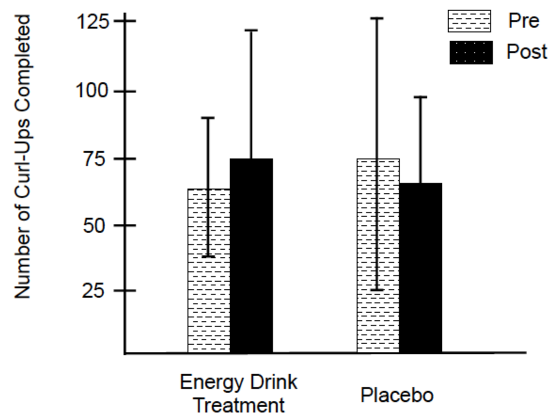

Figure 1. Curl-up to fatigue performance.

DISCUSSION

This study investigated the acute effect of a commercially available, non-caloric caffeine-containing energy drink on several modes of physical performance, including power production (measured via vertical jump), upper-body and trunk local muscular endurance (measured via YMCA bench press and curl-up test and), and repeated sprint speed performance (measured via the completion of ten, 20-meter sprints). The major findings of the study indicated that ingestion of a non-caloric energy drink (containing approximately 2.4 mg caffeine/kg body mass) did not contribute to an improvement in any measure of physical performance.

Several other studies have investigated the effects of energy drink ingestion on power production as evaluated via vertical jump performance (6, 10, 22). Fernandez-Campos and colleagues (10) instructed professional female volleyball players to ingest a carbohydrate and caffeine containing energy drink (which also contained other ingredients) 30 minutes prior to a vertical jump assessment. It was reported that pre-exercise energy drink ingestion exerted no improvement in vertical jump performance as compared to a placebo and control treatment. In contrast, three other investigations that contained higher caffeine concentrations in the pre-exercise energy drink ingestion reported significant increases in vertical jump following consumption (1,6,22). Specifically, vertical jump was significantly improved by 3.4% (22), 4.8% (1) and 5% (6) as compared to a placebo treatment. Each of these investigations included highly skilled or elite level athletes (volleyball and badminton players) in which the energy drink contained caffeine in the amount of 3mg/kg of body mass. In the reports in which vertical jump was not improved, the energy drinks contained lower amounts of caffeine: 2.4 mg/kg body mass in the current study and 1.2 mg/kg body mass in the Fernández-Campos (10) investigation. Based on this information, there may be a threshold for caffeine content that must be present in the energy drink beverage in order to induce improvements in vertical jump performance. This caffeine threshold appears to be met with a 3mg/kg body mass dose. This dosage of caffeine is consistent with recommendations put forth by the International Society of Sports Nutrition, which states that caffeine is effective for enhancing sport performance in trained athletes when consumed in low-to-moderate dosages (~3-6 mg/kg) and overall does not result in further enhancement in performance when consumed in higher dosages (≥ 9 mg/kg) (13).

The current study assessed muscular endurance via the YMCA bench press test and the curl-up test that is utilized in the US Navy Physical Readiness Test. In both assessments of muscular endurance, the pre-exercise energy drink did not induce an enhancement of muscular endurance. Eckerson and coworkers (9) investigated the effects of a pre-exercise sugar-free, caffeine-containing energy drink (provided 60-minutes prior to exercise) on upper body muscular endurance in resistance-trained males. Upper body muscular endurance was assessed via the completion of as many repetitions as possible at 70% 1RM bench press. Similar to the current study, the pre-exercise energy drink had no effect on upper body muscular endurance. The amount of caffeine present for this study was 2 mg/kg body mass (9), which was similar to that utilized in the present study (approximately 2.4 mg/kg body mass).

Forbes and colleagues (11) appear to be the first to examine the effect of a commercially available energy drink on upper body muscular endurance, and their results showed that a caffeine-containing energy drink (2 mg/kg body mass) ingested 60 minutes prior to exercise significantly increased the total number of bench repetitions over 3 sets at 70% 1RM compared with a placebo treatment in healthy young males and females. However, in agreement with the current study and the Eckerson study (9), there were no significant differences when comparing single sets of bench press repetitions to placebo. The findings of Forbes et al. (11) suggest that a caffeine-containing energy drink may be more effective when performing repeated sets of an upper body muscular endurance test as opposed to a single set. It may be that greater levels of fatigue are needed (such as what would be expected with repeated sets of a muscular endurance test) in order for a pre-workout energy drink to induce improvements in muscular endurance performance.

Duncan et al. (8) reported that a caffeine-containing energy drink (containing nearly the same amount of caffeine as used in the current study [179 mg vs. 163 mg, respectively]) significantly improved muscular endurance in resistance-trained males. Sixty-minutes prior to completing four exercises (bench press, deadlift, prone row, and back squat) to failure at 60% 1RM, the energy drink was consumed. The energy drink treatment induced a significant increase in the number of repetitions to failure, irrespective of exercise, as compared to the placebo condition. While this outcome was favorable in relation to whole body muscular endurance; unfortunately, data was not provided for the bench press exercise alone, so a direct comparison between the current study and this investigation cannot be made relative to upper body muscular endurance.

Based on the findings of the current study and available literature, it appears that energy drinks containing modest levels of caffeine (< 3mg/kg body mass) do not improve upper body muscular endurance when assessed with one exercise consisting of a single set to failure (9). However, when multiple exercises or repeated sets of an upper body muscular endurance test are employed, pre-exercise energy drinks intake with caffeine concentrations that are lower than 3 mg/kg body mass are capable of enhancing muscular endurance.

In addition to caffeine, the non-caloric energy drink used in the present study also contained β-alanine. β-alanine is an ingredient that is capable of improving anaerobic performance in exercises resulting in an elevated intramuscular acidotic environment (3,17). The assessment utilized in the present investigation to measure upper body muscular endurance – the YMCA bench press, is able to induce an elevated intramuscular environment given the anaerobic nature and length of the test (typically between 60 and 90 seconds). However, in studies that have reported improvements in anaerobic exercise performance, dosages ranged from 4 to 6.4 grams for several weeks, which resulted in a significant increase in intramuscular carnosine levels (3,17). The amount of β-alanine contained in the non-caloric energy drink used in the present study was only 12.5mg. This amount of β-alanine has not been shown to significantly improve exercise performance. Further, ingesting β-alanine as a pre-workout supplement at such low levels will not elevate intramuscular carnosine levels chronically over several weeks. For these reasons, it is not surprising that YMCA bench press performance was not improved, even with the inclusion of β-alanine as one of the primary ergogenic ingredients.

A recent study also investigated the effects of a pre-workout energy drink and its effects on repeated sprint performance (15). Twenty male American football players ingested an energy drink (containing 120mg caffeine) or an isoenergetic, isovolumetric, non-caffeinated placebo sixty minutes prior to performing six 35-meter sprints with 10 seconds of rest between sprints. Seven days later, the participants ingested the alternative beverage in a double-blind, randomized, crossover design. It was reported that the pre-workout energy drink ingestion did not improve repeated sprint times in the sample of collegiate football players. Similarly, repeated sprint times (six 30-meter sprints) were not improved in female rugby players sixty minutes following energy drink consumption (providing 3 mg caffeine/kg body mass) as compared to a placebo treatment (7). These reports are in agreement with the findings of the current study in which repeated sprint times were not improved with pre-exercise energy drink ingestion.

The present study did not observe improvements in vertical jump performance thirty minutes following the consumption of a calorie free energy drink as compared to a placebo treatment. Other investigations that have reported conflicting outcomes utilized energy drinks that contained higher levels of caffeine, often at doses of 3 mg/kg body mass. The amount of caffeine present in the energy drink was approximately 20% lower than this amount, providing 2.4 mg/kg body mass on average. The present study is in agreement with other investigations that have assessed muscular endurance via one exercise consisting of a single set to failure following energy drink ingestion in reporting that muscular endurance is not improved. Finally, the available scientific literature consistently reports that pre-exercise energy drink ingestion does not improve repeated sprint performance, even when the caffeine content is present at levels that improve other performance variables. In conclusion, a pre-exercise energy drink (providing 2.4 mg caffeine/kg body mass) was not effective at improving multiple parameters of physical performance, including upper body and trunk muscular endurance, muscular power, and repeated sprint speed in healthy, college-aged males and females.

ACKOWLEDGEMENTS

This study was partially funded by Vital Pharmaceuticals (VPX) with product and placebo.

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