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Original article

Effect of Big Bear energy drink on performance indicators, blood lactate levels and rating of perceived exertion in elite adolescent female swimmers

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Summary. There is little information about the effect of energy drink on elite adolescent female swimmers. The aim of this study was to investigate the effectiveness of energy drink to improve physical performance and some physiological factors in female swimmer players. 36 elite adolescent female swimmers (all participants in the national competition authority had earned or were invited to national team; 13.73±1 years, weight 45.67±3.70, height 149.5±7.30 cm and body mass of 20.39±1.5 kg/m^2) Volunteered to participate in this study. A double-blind, placebo controlled and randomized experimental design was used in this investigation. In two sessions with an interval of 4 days of each other, 36 female swimmers ingested 6 mg/kg Big Bear energy drink or placebo. 15 min after consumption, they performed of tests as below: one repetition maximum and 60% of one repetition maximum in the chest press and leg press, explosive power test, anaerobic RAST test, 100 m swim Crawl at maximal speed, aerobic Queens College Step test. Also before, immediately after RAST test, 5 cc of blood from brachial vein to measure blood lactate was taken from subjects, and the results were recorded. Also, participants rating of perceived exertion (RPE) scale (Borg 15 rank) filled out before and after the muscular endurance test. In comparison to the placebo drink, the ingestion of drink reduces the 100 m crawl record (97.12±4.68 s vs 94.73±4.37 s, respectively; P=0.02). The ingestion of the energy drink did not affect other performance indicators. Also, blood lactate levels and RPE during the post exercise was unaffected by the energy drink ingestion. An energy drink with a dose equivalent to 6 mg/kg ineffective on performance indicators (muscle strength, muscular endurance, explosive power, aerobic power, anaerobic power), blood lactate levels and rating of perceived exertion in elite adolescent female swimmers.

Keywords: energy drinks, performance, blood lactate, adolescent female.

Introduction

Energy drinks were introduced in the United States in 1997 (1). Over the last decade, energy drinks have grown in popularity among youth, with reported consumption prevalence varying from a daily prevalence of 5% to biweekly prevalence of 42% among youth (2). Recent evidence suggests that energy drinks are available in more than 140 countries (3). The United States energy drink industry is anticipated to reach nearly 20$ billion by 2013, an increase of almost 160% since 2008 and it is estimated that 24–56% of the adolescent to middle aged population are energy drink consumers (4). In addition, consumption of energy drinks by athletes has become increasingly popular. Athletes believe that energy drinks can be used to enhance their performance during training and competition due to their potentially ergogenic ingredients such

as carbohydrates, caffeine, sodium and taurine, among others (5).

Marketing strategies are aimed at young, athletic populations. Supplement companies are frequently serving as event sponsors, and their products are endorsed by competitive athletes (3). Also, they state that these productsmay boost energy, concentration, and athletic performance (2). The success of these strategies is evidenced by reports indicating that half of the energy drinks are sold to individuals of 25 years and younger (3).

The Food and Drug Administration (FDA) defines energy drinks as "a class of products in liquid form that typically contains caffeine, with or without other added ingredients)"6). Thus, energy drinks are a category of beverages that typically contain caffeine. Products in this category include Red Bull, Big Bear, Monster, as well as many others (7). Caffeine is one of the most widely used ergogenic aids (8). Caffeine is one of the most consumed drugs in sports in our days. A recent study has shown that 3 out of 4 elite athletes consume caffeine prior to competing (9).

Although the exact mechanism explaining caffeine's ergogenic effects remains elusive, potential factors include: an increased mobilization of intracellular calcium, free fatty acid oxidation, catecholamine, stimulation of the central nervous system, heart, and skeletal muscles or concurrently, serving as an adenosine receptor antagonist in the central nervous system, improved neural firing rates, reductions in feelings of fatigue and effort (10-12). Caffeine has been proposed to improve physical performance by acting independently (10-12), and/or attenuated perceptions of rating of perceived exertion (13).

Caffeine content varies greatly between brands, with some products containing up to 500 mg per serving (6). According to the Medical Council of International Olympic Committee (IOC), caffeine is allowed in sports as long as its urinary excretion level is below 12 μ g/ml (14), Thus it has been recommended that caffeine dose should be limited to 7 mg per kg of body weight or less to avoid a positive drug (15). In addition, adolescent and child caffeine consumption should not exceed 100 mg/day and 2.5 mg/kg per day, respectively (16). For example, 8 oz of Red Bull provides 77mg of caffeine, or 1.1 mg/kg for a 70-kg male or 2.2 mg/kg for a 35-kg preteen.Whether the effects of caffeine in adults can be generalized to children remains unclear (16).

Another active ingredient commonly found in energy drinks is taurine. Taurine (2-aminoethylsulfonate) is involved in several important physiological functions, including muscle contraction, osmoregulation, anti-inflammatory activity, neuromodulation, antioxidant activity and maintenance of normal mitochondrial function and ATP production (17, 18). Also, energy drinks contain: ginseng, guarana, glucuronolactone, B vitamins, ginkgo, and various other herbal derivatives to their products (4, 6, 19, 20).

Several papers have showed that consumption of supplements and energy drinks before exercise can improve exercise performance and quality of the athletes. A recent study showed that a pre exercise high energy supplement consumed 10 minutes before resistance exercise can enhance acute exercise performance by increasing the number of repetitions performed and the total volume of exercise (21). There is growing evidence that acute caffeine intake enhances repeated sprint performance in athletes. Del coso et al. (2012), showed that caffeine (3 mg/kg) enhanced repeatedly sprint performance (9). In addition, javeir et al. (2014), indicates consumption of a caffeine-containing energy drink pre exercise increases jump performance on basketball players (22). In young men and women, ingestion of Red Bull improved bench press performance, but had no effect on anaerobic power) 23). Also, 500 mL of red bull improved cycling performance in male and female cyclists (24). The enhanced exercise performance resulted in a significantly greater increase in both growth hormone and insulin concentrations, indicating an augmented anabolic hormone response to this pre exercise supplement (21). In contrast to, Beck et al. (2006) and a few other study, finding that ingestion caffeine supplementation not influence on performance (25-27).

Swimming events should be energetically equivalent to middle-distance track running because of similar duration of races (e.g., the 100-m swim and 400-m run both take <60 s, and the 200-m swim and 800-m run both take <2 min) (28). Thus, swimming athletes require elements of muscular strength, power, speed, anaerobic power and endurance to reach their perfor-

mance potential. These physical elements are energetically supported with a combination of phosphate energy system, lactic acid energy system, and aerobic energy sources (28, 29). These elements are developed by the combined training and diet (supplementation). The use of supplements and energy drinks in the last years has been significant increase.

An energy drink brands, the Big Bear. This energy drink has high caffeine and taurine, may have ergogenic effect. The drinks manufacturers in their advertising claim that its use leads to increase metabolic rate, enhance exercise performance and decrease mental fatigue during long periods of consumption. Unfortunately, little research exists regarding the accuracy of these claims.

The main goal of the present study was to investigate, the associations between energy drink (6 ml/kg) consumption pre exercise on performance, blood lactate and rating of perceived exertion (RPE) in elite adolescent female swimmers.

Methods

Subjects

Thirty-six elite adolescent female swimmers volunteered to participate in the study. They had a mean ±SD age of 13.73±1 years, weight 45.67±3.70 kg, height 149.5±7.30 cm and body mass of 20.39±1.5 kg/m^2. All participants in the national competition authority had earned or were invited to swimming national team.

No participant had a previous history of cardiopulmonary disease or was taking medications during the study. Participants underwent a physical examination prior to enrolling in the study and they had no history of respiratory disease and spinal deformity. Furthermore, the day before each experimental trial, participants refrained from strenuous exercise and adopted a similar diet and fluid intake regimen. Each participant and his parent/guardian were informed of the experimental procedures and associated risks of the investigation and an informed consent was signed by the both of them. The protocol of this study was approved by university moral committee.

Experimental design

A double-blind, randomized, crossover counterbalanced design was used in this study. Each player performed tests under the same environmental conditions (24±1˚C; 87±5% of relative humidity). In each session, after a standard breakfast (containing 378 kcal, 48% carbohydrate, 17% fat and 30% protein, about 45 g of bread, 10 g of butter and one cup of boiling water) (30), and use of 6 ml/kg of body weight Big Bear energy drink and placebo (2.5 mg/l and 50 mg of vitamin C powder per liter of sodium saccharin) operated. The beverages were prepared in opaque plastic bottles to avoid identification and ingested 15 min before the onset of the experimental trials. An alphanumeric code was assigned to each trial to blind participants and investigators to the drink tested.

Experimental protocol

Two days before the first experimental trial, elite adolescent female swimmers were nude weighed to calculate the energy drink dosage. The day before each experimental trial, participants refrained from strenuous exercise and adopted a similar diet and fluid intake regimen. Furthermore, participants were encouraged to refrain from all dietary sources of caffeine (coffee,

Table 1. Big Bear energy drink ingredient/100ml

Ingredient	Amount
Energy Drink	211 kj (49.5 kcal)
Caffeine	29 mg
Taurine	0.38 g
Glucuronolactone	0.23 g
Protein	0.4 g
Carbohydrate	11.5 g
Fat	≤ 0.1 g
Fibre	≤ 0.1 g
Sodium	≤ 0.1 g
Vitamin B2	0.4 mg
Vitamin B3	8 mg
Vitamin B5	3.3 mg
Vitamin B6	0.8 mg
Vitamin B12	2.4µg

cola drinks, chocolate, etc.) for 48 h before testing. Then, the beverage assigned for the trial was individually supplied and consumed 15 min before the tests. After that, participants performed a standardized warm-up for 15 min consisting of continuous running and stretching. After the warm-up, participants performed test (see test specifications below): Test to measure the strength of one repetition maximum in the bench press and leg press exercises were used. 60% of one repetition maximum test was used to measure muscular endurance, also to measure the speed of 100 meter crawl and to measure explosive power at threw for medicine ball for upper body power and vertical jump (Sargent) was used for the lower body power. In addition to measuring aerobic and anaerobic power, Queens College Step and RAST[1] Test respectively were used. Blood lactate before and after RAST test was measured. Also, participants filled out Borg RPE[2] scale before and after the muscular endurance test. This scale included a 6 to 20 point to assess Pressure was applied by participants, and participants were previously informed that 6 point meant minimal amount of that item and 20 points meant maximal amount of the item (31).

Muscle strength

Test to measure the strength of one repetition maximum in the bench press and leg press exercises were used. One repetition maximum in the bench press and leg press, the maximum amount of weight that subjects can move it once and was calculated using the formula (32).

1RM = load/ (1.0278-0.0278 (number of repetition to exhaustion))

Muscular endurance

Muscular endurance test with 60% of one repetition maximum in the bench press and leg press exercises, performed as follows: first, 60% of one repetition maximum strength was obtained in the above exercises, respectively. Participants with determined load as much fatigue performed movement, then repetitions were recorded.

Explosive power

To evaluate the explosive power of the lower body vertical jump (Sargent) and to assess upper body power throwing the medicine ball was used.

Speed

The sprint test consisted 100 m swim crawl at maximal speed. This test is a 50-meter indoor swimming pool sweep was conducted.

Aerobic power

Queens College Step Tests on a 41.25 cm step for 3 minutes at work 22 played up and down on minutes was performed. After completing the test, the pulse was recorded for 15 seconds and multiply by 4 to determine the beats per minute and maximum oxygen consumption was calculated using the following formula:

$Vo_2max\ (ml \cdot kg^{-1} \cdot min) = 65.81 - (0.1847 \times HR)$

Anaerobic power

Anaerobic power was measured with RAST test, which consisted of 6 repetitions at a distance of 35m and the maximum intensity is a quick run with 10 seconds rest between each repetition (during the test was recorded by the timer carefully 0.01 seconds) and was calculated using the following formula (4).

Peak anaerobic power = weight (kg) × 35^2 ×repeated fastest time[3]

Blood sampling

For measurement of lactate, before and after the RAST test, the amount of 3 cc of blood from the brachial vein in the sitting position, the safety precautions taken by the laboratory technician and was then transferred to the laboratory, using Enzymatic method measuring lactate and results were recorded.

Statistical analyses

Descriptive statistics were used to determine the properties of the indicators mean and standard deviation of the participants in terms of age, height, weight, the SPSS version 20 was used for statistical analysis. After ensuring a normal distribution using the Kolmogorov-Smirnov test, the dependent variables between energy drink consumers and placebo were compared by paired samples t-test. Significance level was $P \leq 0.05$ considered.

[1] Running-based Anaerobic Sprint Test
[2] Rating of perceived exertion

Result

In comparison to the placebo, the pre exercise ingestion of the energy drink reduced the 100m crawl record (P=0.02, Table 2). In addition, other performance indicators include: muscle strength, muscle endurance, explosive power, aerobic power, anaerobic power and blood lactate levels during the post exercise was unaffected by the energy drink ingestion (P>0.05, Table 2). In comparison to the placebo, the pre exercise energy drink intake tended to decrease RPE during muscular endurance test, although the differences did not reach statistical significance.

Discussion

The aim of the present investigation was to determine the effects of ingesting energy drink on physical performance of elite adolescent female swimmers.

The study finding showed that energy drink consumption significantly increases the speed of athletes, but has no significant effect on other indices, blood lactate and RPE. Although scientific research on performance indicators to evaluate the impact of Big Bear energy drink does not exist, but most of the other the drinks and their impact on athletic performance has been done.

The main active ingredient in Big Bear energy drink is caffeine. Mechanisms responsible for the effect caffeine ingestion on exercise performance include: increase in free fatty acid oxidation and enhanced muscle glycogen spare (10), facilitate neuromuscular function at the level of the sarcoplasmic reticulum via release calcium on sarcoplasmic reticulum, increase plasma epinephrine concentrations, Enhances motor unit recruitment via acting as an adenosine receptor antagonist on the central nervous system (5, 33-35). Caffeine has been shown to reduce plasma potassium levels

Table 2. The mean and standard deviation of the measured variables between energy drink consumers and placebo.

	Variable	Pre-test	Post-test	P
Muscular strength (bench press) (kg)	Placebo Energy drink	19.63±3.20 20.05±3.79	19.95±3.08 20.94±3.06	0.42
Muscular strength (leg press) (kg)	Placebo Energy drink	68.23±12.34 71.11±9.02	69.31±11.75 73.07±8.69	0.37
Muscular endurance (bench press) (rep)	Placebo Energy drink	19.9±4.5 21.2±3.5	20.3±4.4 21.7±4.1	0.87
Muscular endurance (leg press) (rep)	Placebo Energy drink	29.9±5.5 28.8±5.6	30.1±5.2 29.6±5.4	0.23
Upper body Explosive power (cm)	Placebo Energy drink	257.37±22.57 262.63±26.63	262.36±.23.30 266.84±28.10	0.24
Lower body Explosive power (cm)	Placebo Energy drink	31.9±6.85 32.2±6.45	34.8±6.50 36.6±5.15	0.08
Speed (S)	Placebo Energy drink	95.59±3.99 97.12±4.68	95.45±4.40 94.73±4.37	0.02*
Aerobic power (ml/kg/min)	Placebo Energy drink	37.50±2.44 38.21±3.11	38.05±2.90 39.78±2.07	0.22
Anaerobic power (W)	Placebo Energy drink	345.55±35±70 358.29±37.11	339.90±30.50 350.66±40.89	0.52
RPE	Placebo Energy drink	- -	12.84±0.58 10.78±0.49	0.06
Lactate (mMol/L)	Placebo Energy drink	1.38±0.25 1.70±0.19	9.96±1.4 9.74±1.22	0.20

** Indicates a significant difference between the placebo and Energy Drink consumers in level of P ≤ 0.05.*

compared with placebo during exercise, the increased intracellular potassium concentration coupled with lower extracellular potassium might help maintain membrane contractility during exercise (4, 10). The molecular mechanism of caffeine involves blockage of adrenergic receptors leading to an increase in cAMP concentration and inhibition of cAMP catabolism (36). These mechanisms most likely occur with larger caffeine doses (23), while the amount of caffeine in Big Bear energy drinks not enough that can be cause these effects. Also, recently it was found that larger doses of caffeine might have negative health consequences such as impaired glucose tolerance.

The results of the present study showed that consumption of energy drinks increases the speed that is accordance with the results Del Coso et al. (2012).

Del Coso et al. (2012), showed that caffeine containing energy drink a dose equivalent to 3 mg/kg, 30 min before the onset of the experimental increased the ability to repeatedly sprint during 7×30 m running sprints with 30 s of active recovery between repetitions (9), also Collump et al. (1992), found that caffeine ingestion (250 mg) 1 h before 100 m freestyle swimming significantly improved performance time (37). On the other hand, Astorino et al. (2012), indicate that consumption 255 ml of Red Bull containing 1.3 mg /kg of caffeine and 1 g of taurine, 1 h pre exercise, does not alter repeated sprint performance (3×8 sprint test) on women's soccer performance (13), also Del Coso et al. (2013), showed ingestion 3 mg/kg of caffeine via an energy drink , 60 min pre exercise ineffective on increase sprint velocity during a 6×30 m sprint test to women rugby players before an international competition (38). Thus, it appears that the amount of caffeine and its use as the main factors used to obtain the performance benefits gained from consuming energy drinks.

The results Doherty et al. (2005), demonstrate that caffeine reduces RPE during exercise and this may partly explain the subsequent ergogenic effects of caffeine on performance (39). However, our data reveal no change in RPE during endurance muscular compared to placebo. Santos et al. (2014), reported that ingestion of an acute, moderate dose of caffeine (5 mg/kg) 1h pre exercise not influence on RPE (40). Ivy et al. (2009), reported no difference in RPE during cycling in response to 500 mL of Red Bull (24). Astorino et al. (2012), finding that consumption Red Bull no change in RPE during repeated sprinting compared to placebo (13).

Taurine or L-Taurine is the most abundant amino acid in muscle later glutamine (15). However, new research by scientists has shown that the most abundant amino acid taurine in type II muscle fibers, even more glutamine that increases strength athletes (15). This amino acids in the body is produced by the metabolism methionine and cysteine and of several physiological processes such as muscle contraction cardiac and antioxidant activity is involved (4, 15, 18). Taurine is found in high concentrations in skeletal muscles and is thought to play a role In modulating contractile function (4), which then decreases with exertion like other nutrients When sarcoplasmic reticulum calcium release in muscle filament and binds to troponin, taurine increases the amount of calcium released and the cells more sensitive to calcium response and further increased contractibility (4, 18). It seems like creatine, taurine has several important functions and can act as the body's cells and promotes increased cell size (15). In the present study, this effect was not observed. It seems that due the ingredients and amount of taurine in Big Bear energy drinks.

Study Forbes et al. (2007), demonstrated significant increase body muscle endurance the effect of consumption Red Bull (2.0 mg/kg caffeine) 60 minutes before the test (23). In contrast to, research conducted by Astorino et al. (2008), and Beck et al. (2006), showed that supplements containing caffeine has no effect on muscular endurance and muscular strength, which is consistent with previous results (41, 25).

In contrast to our findings, previous studies reveal improved aerobic performance with ingestion caffeine containing energy drinks. Byars et al. (2006), indices of cardiorespiratory fitness, specifically VO_{2max} and Time are enhanced the effect ingestion 20 minutes pre exercise drink. Perform each maximal effort exercise test on a motor-driven treadmill (30). Ivy et al. (2009), found that consuming a 500 mL of Red Bull containing 160 mg of caffeine, 40 min before exercise improve endurance performance on male and female competitive cyclists. Test was performed on sport cycle ergometer (24). In contrast to, Dragoo et al. (2011), and Rob-

erts et al. (2007), finding that ingestion caffeine supplementation (2 mg/kg) not influence on performance aerobic (26, 27). Is known that, oral caffeine doses as low as 2-3 mg/kg to improve endurance performance while doses below 2 mg/kg have shown no effect (26).

Forbes et al. (2007), found no significant difference with the consumption of Red Bull energy drink (2.0 mg/kg caffeine) (23), also several studies have found that moderate amounts of caffeine containing energy drink (3–6 mg/kg) was ineffective to increase anaerobic power production during Wingate test (14, 25, 26).

Several investigation have found that energy drink (3 mg/kg body weight) 60 min pre exercise was effective to increase jump performance during test included 15 s jump test and countermovement jump on semi-professional soccer players, woman international rugby players and basketball players, female soccer players. (9, 22, 34, 38). In contrast, in this present we have found that 6 mg/kg Big Bear energy drink 15 min pre exercise not influence on Explosive power during vertical jump. It seems that the reason for this difference is types Consumption of energy drinks, ingredients and the time consumption of energy drink. Caffeine is completely absorbed within the stomach and the small intestine 45 min after ingestion, and its half-life in the body is 3–4 h (13). So to get the maximum effect of caffeine containing energy drink should be consumed 45 minutes before activity.

In summary, the present study demonstrated that ingesting 6 mg/kg of Big Bear energy drink 15 min pre tests, no significant effect and only makes enhanced elite adolescent female swimmers speed, and makes Swimming 100 m crawl record of reducing. Thus Big Bear energy drinks ineffective on performance indicators (muscle strength, muscular endurance, explosive power, aerobic power and anaerobic power), blood lactate levels and rating of perceived exertion in elite adolescent female swimmers.

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