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RED BULL IMPROVES SPORT PERFORMANCE: FACT OR FICTION?

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ABSTRACT

Kaczrowski KL, Lynnes TC, Lochowitz WM, Spangberg CM. Red Bull Improves Sport Performance: Fact or Fiction? *Journal of Undergraduate Kinesiology Research* 2007; 3(1) 18-26. **Purpose:** Red Bull is one of the many energy drink choices available to consumers and is utilized in an effort to enhance physical performance. Caffeine, one of Red Bull's main ingredients, is a nervous system stimulant that is thought to provide numerous exercise-enhancing effects including: increased neuromuscular transmission and functioning, improved cardiovascular endurance, and an enhanced ability to achieve peak skeletal muscle strength. Theoretically, the consumption of this product should increase physical performance. Therefore, the purpose of this study was to examine the effects of Red Bull on performance attributes of speed, vertical jump, strength, and anaerobic power in moderately active, college aged individuals. **Methods:** We tested 15 moderately active, college aged subjects (8 males and 7 females) between the ages of 18 to 22 years. Our study was randomized and double-blinded to ensure both subjects and test administrators would not know whether the subject consumed a Red Bull energy drink or a placebo prior to the testing procedure. We required all participants to attend a familiarization session prior to actual testing sessions to negate experience as a limitation. The testing process measured speed, vertical jump, strength, and anaerobic power via a 40 yard dash, vertical jump test, one repetition maximum (1-RM) bench press, and Wingate test, respectively. **Results:** There was a significant difference ($p \leq 0.05$) in average 40 yard dash speed following Red Bull (M=5.681s ± 0.669s) vs. placebo consumption (M=5.729s ± 0.695s). No other performance measures showed any statistical significance. **Conclusion:** With the exception of average speed, our study demonstrates that Red Bull does not enhance physical performance. Consequently, it does not seem worth the two dollar cost of the drink for those looking to increase physical performance.

Key Words: Caffeine, ergogenic aid, strength, power, anaerobic, energy drink

INTRODUCTION

One of the most widely consumed drugs among athletes in today's world is caffeine (4). Caffeine is a nervous system stimulant, which has been thought to provide numerous exercise-enhancing effects that may be helpful to an athlete looking to improve his or her performance of a particular sport. Due to these performance-enhancing effects, caffeine is considered to be an ergogenic aid. Ergogenic aids are defined as work-enhancing agents that are used in attempts to increase athletic or physical performance capacity (2). A few of the proposed benefits of caffeine ingestion prior to exercise include: increased neuromuscular transmission and functioning, improved cardiovascular endurance, and an enhanced ability to achieve peak skeletal muscle strength (1,4). These types of benefits could be considered advantageous to athletes participating in sports requiring repeated speed, strength, and power movements.

Red Bull is one of the many energy drink choices available to consumers. According to the manufacturer's website, www.redbull.com, the consumption of their product will improve performance, increase concentration and reaction speed, and increase endurance. These claims have been made because two of the product's main ingredients are taurine and caffeine. Taurine functions primarily in electrically active tissues such as the brain and nervous system and could play a role in muscle contractile function (3). This may provide an ergogenic property due to taurine's effect on cardiac contractility (7). Caffeine's primary role lies within blocking adenosine receptors in the central nervous system (11). Adenosine hinders the release of several excitatory neurotransmitters in the brain, which are associated with a reduction in arousal and the inhibition of spontaneous brain activity (11). Due to caffeine's adenosine blocking effects, an ergogenic property results that may delay the onset of fatigue (11). Overall, the combination of these two ingredients has been thought to enhance athletic performance.

Previous research regarding the ingestion of caffeine prior to the performance of activities involving speed, strength, vertical jump, and power has shown a variety of results. Beck et al. conducted a study to examine the effects of caffeine on muscular strength, endurance, and anaerobic capabilities (4). The results suggested that caffeine supplementation provided a significant increase in one repetition maximum (1-RM) bench press strength, but did not affect any of the remaining performance measures of leg extension strength, muscular endurance, and mean and peak power output (4). Likewise, a study by Greer and colleagues looked at the effects of caffeine consumption on repeated Wingate anaerobic power tests and found no improvement in exercise performance (5). Further noted in this study was that the power output of several of the subjects continually decreased as the tests progressed (5). However, an experiment by Schneiker et al. examined the effects of caffeine supplementation on intermittent-sprint performance of sprinting bouts of six seconds in duration (6). Their findings indicated that caffeine ingestion showed a significant improvement in sprint performance (6).

Research specifically concerning the effects of Red Bull on physical performance has also varied. Alford et al. conducted a study to determine if Red Bull had any effect on aerobic and anaerobic cycling endurance (1). The aerobic assessment involved bringing participants to 65-75% of their maximal heart rate and maintaining this range as long as possible. When the heart rate moved outside this boundary, the elapsed time was recorded as the subjects' maximum aerobic endurance threshold (1). The anaerobic test consisted of an all-out sprint lasting 20 seconds in duration (1). The results indicated that Red Bull provided significant increases in both aerobic and anaerobic cycling endurance by 9% and 24%, respectively (1). However, an experiment by Mueller and colleagues studied the effects of Red Bull on Wingate performance of college-aged students (8). The researchers reported no significant improvement in anaerobic power from the Wingate test after consumption of the beverage (8).

Since research regarding the effects of Red Bull energy drink on sports performance has been limited, we have attempted to use this investigation to add support to this topic. The purpose of this study was to determine the effects of Red Bull energy drink on sport specific attributes of speed, vertical jump, strength, and power in comparison to a placebo. Based on previous research and the claims by Red Bull's manufacturer, we hypothesized that the consumption of Red Bull would increase physical performance of all sport specific variables.

METHODS

Subjects

The participants in our research study consisted of 8 moderately active men and 7 moderately active women between the ages of 18 and 22 years old. Moderately active is defined as 30 minutes of moderate intensity exercise 3 to 5 days per week (ACSM, 2005). The amount of caffeine ingestion varied among subjects, but did not exceed one dose per day. We chose our participants via flyers, mass emails, and word of mouth. Subjects were required to complete a health history questionnaire and PAR-Q to ensure that they had met all of the pre-testing requirements and that they were healthy enough to complete the study. Once the subjects were determined, we obtained written informed consent in addition to subject demographics, which are shown in Table 1. Subjects were then required to attend a familiarization session to get acquainted with the specific testing procedures. This research study was approved by the University Human Subjects Institutional Review Board.

Table 1. Subject Demographics

Variable	Mean ± Standard Deviation
Age (yrs)	20.3 ± 1.4
Height (cm)	172.6 ± 8.0
Weight (kg)	71.9 ± 13.5

Instrumentation

The Wingate Anaerobic Tests were performed on a cycle ergometer (Monark Ergomedic 894 Ea, manufactured in Sweden), and the results were determined using the Monark Anaerobic Test Software Version 1.0. The 40 yard dash distance was measured using a standard 200 foot fiberglass measuring tape with three standard cones marking the start and finish lines. In addition, two Robic Single Event Stopwatches (SC-500.E) were used to time the subjects' speed. The vertical jump test results were found using a Vertec (Questek Corp., manufactured in the U.S.A.), and the one repetition maximum (1-RM) test was done on a standard U.S. Magnum Fitness Systems bench press apparatus with Olympic Standard barbell and weights. Weight and height were measured using a calibrated Detecto scale (Model 437, manufactured in Webb City, MO) and a stadiometer (Seca Model 220), respectively.

Procedures

Subjects attended a familiarization session where pre-testing considerations and protocol procedures were explained. Pre-testing considerations included no caffeine or alcohol 48 hours prior to testing, no high-intensity exercise 24 hours prior to testing, and no large meals two hours prior to testing. In addition, subjects were instructed to get a good night's sleep (six to eight hours) and maintain typical daily activities throughout the research study. In order to ensure that the participants met the pre-testing requirements of being moderately active, non-habitual caffeine users, and in good health, they were asked to accurately complete a health history questionnaire and PAR-Q. The subjects also had to complete a written informed consent document during this session. Lastly, subject demographics were taken concerning age, weight, height, and vertical reach height. The familiarization session lasted approximately one hour per subject.

This research study was administered using a randomized, double-blind experiment. In addition to the familiarization session, the subjects participated in two testing sessions (at least 72 hours apart) where they received either the placebo or the Red Bull; however, only the designated mixer knew which drink the subjects were receiving. The energy drink contained diet Red Bull (Red Bull North America, Inc., Santa Monica, CA), 100 mL of Schweppes tonic water (Schweppes International Limited, Amstelveen, Netherlands), and raspberry-flavored Crystal Light (Kraft Foods, Inc., Northfield, IL), whereas the placebo contained only Schweppes tonic water and raspberry Crystal Light. The order in which the subjects received the beverages was completely random. Furthermore, the same amount of Red Bull was given to each subject based on his or her individual body weight to ensure all subjects received a similar dose and effect from the drink. An equation was created by dividing 250 mL of Red Bull (the amount in one can) by an average U.S. body weight of 80 kg (WedMD, 2004), which equals 3.125 mL/kg. The individual's body weight was then multiplied by this number to find the volume of Red Bull he or she ingested prior to testing. For example, a female subject who weighs 60 kg would ingest 187.5 mL of Red Bull, plus the constant 100 mL of tonic water and Crystal Light packet (3.125 mL x 60 kg = 187.5 mL + 100 mL = 287.5 mL). Likewise, the placebo would contain a total of 287.5 mL of Schweppes tonic water with a packet of Crystal Light. This procedure ensured that the amount of liquid for the energy drink and the placebo was the same.

The energy drink and placebo were administered to the subjects 45 minutes before testing began. Several research studies used between 30 minutes and 60 minutes for the time between ingestion of beverages and exercise testing (1,4,5,6,7,9,10). Therefore, we chose to average these times and have our subjects test 45 minutes after ingestion. Subjects were asked to finish their drinks within five minutes and then sit quietly until testing started. The order of events for all subjects was consistent. The 40 yard dash test was first, followed by the vertical jump and one repetition maximum tests, and finally the Wingate test. Rest periods were required for every subject between all trials and events and were designed to maximize recovery.

<u>40 YARD DASH</u>

- Subjects warmed up for five minutes on a treadmill at a speed of 3.5 mph before they completed three trials of the 40 yard dash.
- The subjects were required to start each run the same in a staggered stance with one hand touching the ground. The start was consistent for all trials.
- Two testers timed each subject by starting the clocks when the subjects began running and stopping the clocks when the subjects' feet crossed the designated cones.
- Subjects were allowed to rest between one and three minutes between trials, and the amount of rest time varied among subjects.
- The results were averaged, and the subjects' best times and average times from the three trials were used as data in this study.

<u>VERTICAL JUMP</u>

- The subjects completed three trials of the vertical jump test, and the best measurement was taken.
- Vertical jump results were determined by measuring the maximum height attained with one hand during a two-footed vertical jump.
- Subjects were allowed to rest between 30 seconds and one minute between trials.

- The results were then subtracted by the subjects' vertical reach heights to find the actual vertical jump distances.

<u>1-RM</u>

- The one repetition maximum is the greatest amount of weight the subjects could lift once through a full range of motion.
- The subjects warmed up by lifting a light to moderately-heavy weight for 7 to 8 repetitions.
- The subjects then performed 3 repetitions at a slightly heavier weight.
- Next, weights were continually added to the barbell until the subjects could no longer perform 1 repetition through a full range of motion. The subjects were permitted to rest between three and five minutes between sets.
- If the subjects could not perform 1 repetition at a particular weight, the weight was then decreased to the next lowest weight that the subject could lift once successfully.

<u>WINGATE</u>

- The Wingate test was done to find the subjects' anaerobic power levels.
- Once the bike seat height was adjusted, subjects performed an additional warm-up on the cycle ergometer for 5 minutes at a moderate intensity with a resistance of 1.5 kg on the weight basket.
- During this time, subject demographics were entered into the computer software, and the predicted weight in kilograms (based on the subjects' heights and weights) was added to the weight basket for resistance during the test.
- After the warm up, the test started when the subjects were instructed to pedal as fast as they could.
- When maximum speed was reached, the weight basket was dropped, and the subjects had to pedal with maximal effort for a duration of 30 seconds.
- When the 30 second test was over, the weight basket was lifted, and the subjects started a five minute cool-down at a self-selected intensity and resistance.
- This test was done in silence to ensure controlled testing environments for all subjects.

Statistical Analyses

All analyses were performed using Statistical Package for the Social Sciences, Version 15.0 (SPSS, Inc, Chicago, IL). Measures of centrality and spread are presented as mean ± *SD*. Mean differences in performance (speed, explosiveness, strength, and anaerobic power) following Red Bull and placebo consumption were assessed with paired *t*-tests. The probability of making a Type I error was set at $p \leq 0.05$ for all statistical analyses.

RESULTS

<u>40 YARD DASH</u>

Comparisons of mean differences (*M*) in 40 yard dash performance measures following Red Bull vs. placebo consumption revealed no significant ($p \geq 0.05$) differences in best times and significant ($p \leq 0.05$) differences in average times: best of 3 measures [M=-0.028, $t(14)$=-0.804, p=0.435]; 40 yard dash average [M=-0.048, $t(14)$=-2.259, p=0.040]*.

<u>VERTICAL JUMP</u>

Comparisons of mean differences in the vertical jump test performance measures following Red Bull vs. placebo consumption revealed no significant ($p \geq 0.05$) differences: vertical Jump test [M=0.593, $t(14)$=1.164, p=0.264].

<u>1-RM</u>
There was no significant difference ($p \geq 0.05$) in 1-RM bench press performance between the Red Bull and placebo: 1-RM [M=-0.001, $t(14)$=-0.002, p=0.998].

<u>WINGATE</u>
Likewise, comparisons of mean differences in Wingate performance measures following Red Bull vs. placebo consumption revealed no significant ($p \geq 0.05$) differences: peak watts [M=-5.402, $t(11)$=-0.456, p=0.657]; peak watts/kg [M=-0.092, $t(11)$=-0.531, p=0.606]; average power watts [M=4.133, $t(11)$=0.660, p=0.523]; average power watts/kg [M=0.058, $t(11)$=0.585, p=0.570]; minimum power watts [M=3.770, $t(11)$=0.217, p=0.832]; minimum power watts/kg [M=0.036, $t(11)$=0.141, p=0.891]; power drop percent [M=-1.720, $t(11)$=-0.602, p=0.559]; power drop watts/kg [M=-0.124, $t(11)$=-0.413, p=0.688].

The mean values and standard deviations (SD) for all strength performance outcomes with Red Bull and placebo consumption are presented in Table 2.

Table 2. Performance Differences for Red Bull vs. Placebo

	Mean ± Standard Deviation	
Variable	Red Bull	Placebo
40 Yard Dash (Best of 3)	5.614 ± 0.659	5.642 ± 0.691
40 Yard Dash (Average)*	5.681 ± 0.669	5.729 ± 0.695
Vertical Jump (cm)	50.969 ± 12.349	50.377 ± 13.090
1-RM (kg)	68.333 ± 34.773	68.335 ± 34.128
Peak Power (W)	675.478 ± 203.814	680.880 ± 218.337
Peak Power (W/kg)	9.275 ± 1.736	9.367 ± 1.980
Average Power (W)	510.893 ± 149.742	506.760 ± 161.689
Average Power (W/kg)	7.041 ± 1.372	6.983 ± 1.582
Minimum Power (W)	385.827 ± 106.020	382.057 ± 116.838
Minimum Power (W/kg)	5.329 ± 0.956	5.293 ± 1.265
Power Drop (%)	41.743 ± 9.900	43.463 ± 6.191
Power Drop (W/kg)	3.948 ± 1.303	4.072 ± 1.079

* Denotes statistical significance

DISCUSSION
The results of this study have led us to reject our research hypothesis that Red Bull would enhance physical performance. We originally believed that the consumption of Red Bull would provide increases in speed, vertical jump, strength, and anaerobic power; however, the results of this study provide very little evidence to support the ergogenic effects of Red Bull. Therefore, the claims made by Red Bull's manufacturer of increased concentration and reaction speed, improved performance, and increased endurance following the use of their product are untrue.

Prior studies focusing on the ergogenic effects of caffeine on physical performance have shown equivocal results. A study conducted by Greer and colleagues tested the effects of caffeine on repeated Wingate anaerobic tests and found that caffeine did not improve anaerobic power output

(5). In the study conducted by Beck et al., caffeine improved muscular strength as measured by the one repetition maximum (1-RM) bench press, but did not improve performance in the remaining variables of leg extension strength, muscular endurance, and anaerobic capabilities (4). On the other hand, an experiment by Schneiker tested the consumption of caffeine on intermittent sprint performance of sprints lasting six seconds in duration (6). Their findings indicate that caffeine did provide a significant improvement in the subjects' speed (6).

Previous research regarding the effects of Red Bull on physical performance has also exhibited equivocal outcomes. Our findings from this study support research conducted by Mueller et al. that Red Bull provides no significant improvement in anaerobic power as measured by the Wingate anaerobic power test (8). On the other hand, our results do not correspond with an experiment performed by Alford and colleagues who found that Red Bull increases aerobic and anaerobic cycling endurance (1). However, cycling endurance is not equal to anaerobic power and may be why our results do not support these findings. Consequently, the ergogenic effects of Red Bull, if any, continue to be unclear. Because of the conflicting results of Red Bull on physical performance, we found it necessary to conduct this study to add to the current knowledge on this topic.

Our study specifically focused on the effects of Red Bull on speed, vertical jump height, muscular strength, and anaerobic power. We are confident that our randomized, double-blind study prevented the subjects from knowing whether they were consuming the Red Bull drink or the placebo. This is important because we did not want the subjects' behavior to be affected by knowing what drink they received. By giving each subject a specific amount of Red Bull based upon his or her body weight, we ensured that he or she received a similar dosage and effect from the drink. Furthermore, we had our subjects wait 45 minutes after ingesting the beverages to provide the caffeine and other ingredients enough time to be fully absorbed and peak in the blood (12). The order that we administered the tests was also crucial in preventing carry-over fatigue, which could negatively affect the results. For example, the 40 yard dash and vertical jump tests require complete body efforts that are short in duration. Consequently, they are not very fatiguing. On the other hand, the Wingate test is a 30 second, maximal body effort that produces considerable amounts of long-lasting fatigue. Therefore, had the order of the tests been reversed to begin with the Wingate test, fatigue would likely influence the subjects' performance on the remaining tests. Rest periods were organized to allow the subjects as much time as needed to fully recover between trials and events, further preventing fatigue from impacting the results. The lengths of all rest periods varied between subjects. These procedures were employed to improve upon previous research limitations that did not take these aspects into consideration.

One of the features of this study was to minimize limitations imposed by earlier experiments. We effectively addressed all of these elements by communicating to our subjects all pre-testing guidelines, conducting a familiarization session to reduce variances in subject experience, and creating a placebo virtually identical to the Red Bull drink. The only limitation present in our study was a malfunction by the Monark Ergomedic 894 Ea cycle ergometer. This caused inaccurate data for three of our subjects' Wingate tests; therefore, these results could not be used in our study. Even with the presence of this limitation, it was not significant enough to affect the overall Wingate test results due to the fact that we still had enough subjects participating in this test.

The results of this study indicate that Red Bull provides a statistically significant improvement in average speed, but has no effect on the remaining attributes of physical performance. In addition, these findings can only be generalized to the moderately active, college-aged population. Future research could be conducted to study the effects of Red Bull on different age groups to see if our results can be attributed to them as well. Furthermore, since average speed was the only variable that showed a statistically significant improvement, future studies could look specifically at the effects of Red Bull on sprint performance of elite sprinters. With the addition of these studies, the body of knowledge regarding the ergogenic effects of Red Bull would be greatly enhanced.

CONCLUSIONS

The manufacturers of Red Bull advertise their product as an energy drink that increases physical performance when consumed. The results of our study refute the manufacturer's claim, even though an ergogenic effect for average speed was found after the consumption of Red Bull. Our rejection of the manufacturer's claim is largely due to the fact that the drink did not have any impact on the remaining attributes of physical performance. Overall, with the exception of average speed, our study provides evidence that Red Bull does not enhance physical performance. Therefore, it does not seem to be worth the two dollar cost of the beverage for individuals seeking improvements in physical performance.

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