The Effect of Caffeine on Vertical Jump in College Athletes

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Literature Review

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In collegiate sports, it is common practice by athletes to use ergogenic aids to gain a competitive edge. By far the most popular aid used among college athletes is caffeine because of its high availability in various foods, drinks, and supplements and because of the benefits seen in various sports. However, more is known about the benefits of caffeine in endurance sports compared to high-intensity sports that utilize the anaerobic energy system (Bloms et al. 2015). In addition, literature is limited in regards to the effect of caffeine on sports specific skills that utilize ballistic movements. Among these various sports, vertical jump performance can be an indicator of how well athletes can perform these tasks. The reason why this is important is because the NCAA has numerous regulations on the use of substances but has allowed the use of caffeine within a certain limit. With caffeine being an accepted substance by the NCAA and showing promising effects for high intensity sport athletes, the effects of caffeine on vertical jump should be reviewed and further developed. In this literature review, the topics that will be covered are the effects of caffeine on vertical jump performance, factors that affect vertical jump height, caffeine’s effect on various high-intensity sports specific tasks, and overall sports performance.

In a studied titled “The Effects of Caffeine on Vertical Jump Height and Execution in Collegiate Athletes,” Bloms et al. (2015) wanted to examine the effects of caffeine ingestion on vertical jump and execution on NCAA Division I athletes. The hypothesis was that caffeine ingestion would increase vertical jump height, peak force production, and rate of force development. The study design was single blind, randomized, crossover using mechanography. An anhydrous pill form of caffeine was used for the treatment group with the placebo also being a pill. The participants’ age ranged from 18-23 with a total of 16 men consisting of 3 track throwers, 2 jumpers, 2 sprinters, 5 baseball players, 4 football players. Participants also included 9 women that consisted of 3 track throwers, 2 jumpers, and 4 sprinters. On test day, athletes continued normal eating habits except that no food was to be eaten 3 hours before trials or consumed caffeine on the day of the test. Procedure consisted of athletes consuming caffeine at 5 mg/kg or the placebo, waiting 60 minutes, and then performing a 10min warm-up before testing. All participants performed 3 squat jumps and 3 counter movement jumps on a force platform with hands placed on hips. Rest consisted of 30 seconds between each jump and 2 minutes between different jumping techniques. Results were that caffeine had a positive effect on both squat jump and counter movement jump height. For the squat jump, the time to half peak force was reduced in the caffeine group compared to the placebo group. Average rate of force development was increased in caffeine group compared to placebo group. Stretch shortening cycle efficiency exhibited no differences when compared to placebo group. The overall conclusion was that squat jump and counter movement jump were significantly improved after caffeine consumption. However, it is important to note that even though the results indicate an improvement in vertical jump height after caffeine consumption at the group level, an evaluation of individual performances show roughly equal amounts of responders and non-responders. Several weaknesses include that the study was not double blind, caffeine was only abstained from for a relatively short period of time, discrepancies in anthropometric characteristics and jump familiarity may have introduced more variability, and that athletes were in different stages of their seasons making fatigue a factor in the participants’ ability to perform.

In another study, “The Effect of Caffeine on Maximal Oxygen Uptake and Vertical Jump Performance in Male Basketball Players,” Tucket et al. (2013) Investigated caffeine and its effect on maximal oxygen uptake and vertical jump after a fatiguing bout of exercise. The hypotheses were that the consumption of caffeine by elite basketball players would increase endurance performance, decrease RER for any given workload, decrease RPE, and increase anaerobic power in the form of reactive strength index. The methods were that the experiment would be a double blind, placebo controlled cross over study. Aerobic parameters were studied using a graded exercise treadmill test to determine maximal oxygen uptake, RER, RPE, and blood lactate profiles which also allowed testing anaerobic power in a fatigued state. Participants were 5 healthy male elite basketball players with an average age of 22 years that were non-smokers and abstained from caffeine 48 hours before testing and alcohol 24 hours before testing. They also had an average daily consumption of caffeine that was less than 500 mg and were encouraged to consume a pre-exercise meal that was high in carbohydrates. Participants completed 2 trials, one with caffeine pills at a dose of 3 mg/kg and one with a placebo. They then waited 60min and did a 5-7 minute warm up run before starting the treadmill test. Trials were done at least 7 days apart but no more than 10. On the second treadmill test, the participants were not allowed to see their measurements in order to avoid the possibility that they would try to beat their original measurements because they could see the numbers. After the test was over, they completed a 15 minute cool down and then they completed 10 RSI jumps. This was done by stepping off a 45 cm step and then rebounding as quickly as possible trying to jump as high as possible. They were also instructed to keep arms to their side. Results were that there were no significant trends found in differences in maximal oxygen uptake, RSI measurements of vertical rebound jump, and RPE between caffeine and placebo. Four of the five subjects showed a decrease in time to reach an RER value. Overall, no hypotheses in this study were supported and suggest that there is no benefit of caffeine in elite male basketball players. Weaknesses to this study were that the type of jump test used was not a sport specific jump and unfamiliarity could have affected the results.

The next few studies in review look at the effect of caffeinated energy drinks on vertical jump performance and sport specific skills. The study “The Ingestion of Caffeinated Energy Drink Improves Jump Performance and Activity Patterns in Elite Badminton Players” investigated the effectiveness of a commercially available energy drink at a concentration of 3 mg/kg body weight on physical performance of elite badminton players. Abian et al. (2015) hypothesized that the caffeine containing energy drink would increase physical performance during badminton specific testing and during a game. Participants were 16 male elite badminton players with an average age of 25.4 years old and were light caffeine consumers at less than 60 mg per day. The experimental design was randomized, cross over, and placebo controlled. Trials were separated by one week and each participant consumed a powdered form energy drink containing caffeine dissolved in 250ml of water and the placebo being identical. Beverages were consumed 60 minutes before testing. On test day, participants performed a 30 minute badminton specific warm-up and then completed a hand grip maximal force production test, a smash jump with and without shuttle cock, squat jump, counter movement jump, and the agility T test. Three repetitions of each test with a minute of rest between repetitions and three minutes between each test were allowed. 15 minutes after badminton specific testing, participants played a 45 minute simulated match. Opponents were selected that one had ingested caffeine and the other the placebo. At the end, players were required to fill out a questionnaire about sensations of muscle power, endurance, and RPE during the match and the following morning were asked about sleep quality, nervousness, GI problems, and other discomforts. The results were that caffeine ingestion improved squat jump height, counter movement jump height, and counter movement peak power. Caffeine ingestion did not improve handgrip force, smash jump height with and without shuttlecock, or agility T test. During the match, caffeine increased the total number of impacts but had no significant differences in mean or peak HR and total points scored. The subjective feelings had no significant difference except for increased insomnia in the caffeine group. The overall conclusion was that caffeine containing energy drinks might be an ergogenic aid in badminton players due to the increased power and height during a squat and countermovement jump and increased number of impacts during a simulated match. A weakness presented was that it is possible the performance of the energy drink player could have affected the physical demands of the placebo player during the match introducing potential variability. The study was also not double-blinded.

Similarly, in the study “Caffeinated Energy Drinks Improve Volleyball Performance in Elite Female Players,” Perez-Lopez et al. (2014) investigated the effects of caffeine on vertical jump height and sport specific movements. The hypothesis was that a caffeinated energy drink would improve volleyball specific physical performance in elite female athletes. The subjects were 13 female volleyball players with an average age of 25.2 years old. During the experiment 4 of the participants were in the follicular phase of their menstrual cycle while the rest were in the luteal phase. The experimental design was double blind, placebo controlled, and randomized. Each player did two trials separated by one week. The dosage of caffeine in the energy drink was 3 mg/kg of body mass that was mixed with water while the placebo was identical but without caffeine. On the day of testing, participants were asked not to consume any source of caffeine or alcohol, and beverages were ingested 60 minutes before testing. The tests were conducted after a 30 minute warm-up and consisted of a standing spike, a jump spike, a maximal spike, squat jump, countermovement jump, block jump, maximal manual dynamometry test on both hands, and the agility T test. Each test was performed twice with a one minute rest period between repetitions and 3 minutes between tests. 15 minutes after the volleyball specific testing, a three set simulated game was played and player actions were recorded and determined to be positive, neutral, or negative. At the end, players were asked to fill out a questionnaire regarding sensations of power, endurance, RPE, and then in the morning answered questions about sleep quality, nervousness, GI problems, and other discomforts. The results were that the energy drinks with caffeine group was greater or increased compared to the placebo in hand grip force, maximal ball velocity in standing and jumping spike, jump heights in all volleyball specific jumps, power production, and reduced the time in the T test. There was no statistical difference for stretch shortening cycle between groups. Analysis of the volleyball game showed that the energy drink group improved proportions of game actions classified as positive and decreased amount of negative actions compared to placebo. Finally, the caffeinated energy drink significantly increased perceived muscle power, no differences in self-reported fatigue, significantly higher prevalence of nervousness, and no differences in other side effects. The overall conclusion is that caffeinated energy drinks are a potential ergogenic aid to increase physical performance and overall success in female volleyball at a caffeine dose of 3 mg/kg of body mass. Weaknesses in the study include not screening for habitual caffeine users and not asking participants to abstain from caffeine for a longer period of time before testing.

In another study, “A Caffeinated Energy Drink Improves Jump Performance in Adolescent Basketball Players,” Abian-Vicen et al. (2014) aimed to determine the effectiveness of ingesting a commercially available energy drink containing caffeine for improving specific skills and conditioning capacities for adolescent basketball players. No hypothesis was explicitly stated. Subjects were 16 young male basketball players with an average age of 14.9 years old. The experimental design was double blind and placebo controlled with repeated measures. The caffeine containing energy drink was in powdered form and mixed with 250ml of water with the concentration of caffeine being 3 mg/kg and the placebo was identical but without the caffeine. Testing was separated by one week where participants underwent testing both with the caffeine energy drink and the placebo. The day before each trial, participants refrained from strenuous exercise and refrained from caffeine and alcohol for 48 hours before testing. On test day, beverages were consumed 60 minutes before beginning a 15 minute warm up. Then participants underwent 5 tests that were a free throw test, three point shot test, counter movement jump test with hands on hips, 15 second maximal jumping test, yo-yo intermittent recovery test, and then were asked to fill out a questionnaire pertaining to sensations of muscle power, endurance, RPE, and then the following morning were asked about sleep quality, nervousness, GI problems, and other discomforts. The results were that caffeine did not increase precision in free throws or three point shot. Caffeine increased countermovement jump height but no significant differences were found in regards to mean power production during the concentric phase of the jump. During the 15 second maximal jumping test there was a higher mean jump height and higher mean leg muscle power output with the caffeine group. No significant differences in the yo-yo test. The caffeine containing energy drink group also had increased perception of muscle power and endurance compared to placebo and also increased perceived vigor/activeness while the remaining side-effects were not affected compared to the placebo. Overall conclusion was that caffeine containing energy drinks were able to increase jumping height during single or repeated jumps but had no effects on the precision of free throws, three point shots or yo-yo test in young male basketball players and also doesn’t present a potential health risk.

The last study in this review is titled, “Caffeine-Containing Energy Drink Improves Physical Performance in Female Soccer Players,” and its aim was to investigate the effectiveness of a caffeine-containing energy drink on improving women soccer players’ physical performance (Gonzalez-Millan et., 2014). The hypothesis of this study was that caffeine at a dose of 3mg/kg in the form of an energy drink would increase vertical jump ability, maximal running speed, and the distance covered at sprint velocity during a simulated match. There were a total of 18 female participants with an average age of 21 years old who had at least 3 years of experience playing soccer and trained for 2 hours a day 3 to 4 days a week. The experiment was double blind, placebo controlled, and randomized. Each participant performed two experimental trials that were separated by one week. Caffeine was administered at a dose of 3 mg/kg in the form of a powdered energy drink dissolved in 250ml of water while the placebo was identical in taste, appearance, and other substance present except caffeine. Participants were also encouraged to refrain from all dietary sources of caffeine and alcohol 48 hours before testing. The experimental procedure started with ingesting beverages and then performing a standardized warm-up. Performance testing began just 60 minutes after beverage intake. The first test was the countermovement jump measured by means of a force platform and then a 7 x 30m maximal running speed test with 30 seconds of active recovery between trials. Then after a 15 minute rest period, participants completed a 2 x 40min simulated soccer game. The teams were made to have a similar amount of participants who received either the caffeine containing energy drink or placebo. During the game, running distance, running speed, and heart rate were monitored. After the game the participants were asked to complete a survey about sensations of power, endurance, and perceived exertion. Then the day after they completed another survey about sleep quality, nervousness, GI problems, or any other discomforts. The results of this study were that caffeine improved jump height and power output, improved the maximal running speed during 7 x 30m maximal running test, increased the total running distance during the simulated soccer game, and increased the total distance at sprint speed during the simulated soccer game. There also were no statistically significant differences between the caffeine and placebo group in the responses of the surveys. Overall this study was strong and had very few weaknesses. The study reported that some of the participants had to drop out because of injuries but overall did not affect the statistical power of the study. The only discrepancy presented in this study, as well as others in this review using energy drinks, was whether or not the other substances in the energy drink contributed to the results seen in this study. However, this was addressed by the researchers by ensuring equal of amounts of these substances in the caffeine containing energy drink and placebo. The conclusion presented by the authors was that caffeine at a dose of 3mg/kg enhanced women soccer players’ jump height, ability to perform repeated sprints, the total running distance and distance covered at sprint velocity during a simulated game thus, caffeine energy drinks might be an effective ergogenic aid to improve performance.

The strengths of the literature reviewed is that the methods are similar in regards to the dosage of caffeine, timing of ingestion before testing, and how counter movement jump and squat jumps were tested . The athletes in the studies were also similar in the demands placed on the energy systems used during their respective sport which is another strength of these studies that increases the legitimacy of the results. But the techniques each athlete utilizes in order to obtain maximal height and usefulness for their sport vary and merits further research in different sports relying on the anaerobic energy system and jump ability. A sport that could potentially benefit from caffeine is the high jump. The ability to achieve maximum vertical height is absolutely crucial in the high jump as is the ability to achieve maximum sprint speed repeatedly. The energy systems used in this sport also utilize the anaerobic energy system and require the athlete to do so repeatedly. With the literature showing athletes of various sports and ages benefiting from the use of caffeine and the high jump falling into the category of a high intensity ballistic sport, research should next be directed towards college athletes competing in this sport.

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