Effects of caffeinated gum on a basketball-specific tests in trained university male basketball players: a crossover trial

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Project summary

This study investigated the effects of chewing 3 mg/kg of caffeinated gum on basketball free throw accuracy and basketball -specific performance. Fifteen trained basketball players with at least a top 8 national ranking were recruited to be participants in this study. After 2 simulation tests to familiarize the experimental procedure, we employed a double blind, randomized crossover design to divide participants into caffeine trial (CAF) and placebo trial (PL). The CAF trial chewed caffeine gum containing 3 mg/kg for 10 minutes, whereas the PL trial chewed a placebo gum without caffeine. After 15 minutes rest, the stationary free throw shooting test, countermovement jump, t-test, 20-meter segmented dash test, squat in the flywheel device and running based anaerobic sprint test were conducted.

Introduction

Basketball is a sport that combines physical fitness and shooting skills. In order to improve the specialized athletic ability of basketball, it is possible to improve the specialized physical ability and the specialized technical ability. During a basketball game, there are many sprints, jumps, folds, and other high-intensity movements. Therefore, for the specialized physical ability of basketball players, it is necessary to effectively improve the indicators of sprinting speed, agility, explosive power and anaerobic capacity (1, 2). In terms of technical ability, basketball players need to have specialized movement skills and the ability to shoot from different directions and distances. Improving these specialized skills has been found to be the key to improving the winning percentage in basketball (3). Therefore, nutritional supplementation, such as caffeine intake, has been found to improve both physical fitness and cognitive functioning (4) which is important for improving the athletic performance of basketball players.

Caffeine (1, 3, 7-trimethylxanthine) is a popular nutritional supplement for many athletes and is widely found in various foods such as coffee, chocolate, tea, cola and energy drinks. Pre-exercise caffeine intake can significantly increase sprinting speed (5) , repetitive sprinting ability, maximal muscle strength, and explosive power (6) by antagonizing adenosine receptors to reduce fatigue, enhancing the ability of the plasma reticulum to release calcium ions, maintaining the activity of the sodium-potassium

ATPase (Na+/K+-ATPase), and increasing glycolysis (7, 8). The increase in these fitness abilities related to basketball-specific fitness may be effective in improving basketball-specific performance. In addition, caffeine supplementation has been found to be effective in enhancing limb control and cognitive function (9). These abilities may be related to specialized technical abilities in basketball. It has been found that pre-exercise caffeine supplementation with 3-6 mg/kg of body weight, digested and absorbed, is effective in enhancing performance in ball sports, including basketball, by reaching the highest concentration in the bloodstream one hour after ingestion (2, 4). However, caffeine is absorbed more slowly through the gastrointestinal tract, which may result in fluid overload or gastrointestinal discomfort (10). Seeking alternative forms of caffeine supplementation may reduce discomfort and prevent the fluid overload.

Chewing caffeinated gum has been found to have a faster rate of caffeine absorption via the buccal mucosa compared to caffeine capsules (11). In a study by Morris et al. (2019), subjects were allowed to chew 100 milligrams of caffeine for 2, 5, and 10 minutes, and the absorption rate of caffeine as well as the concentration in the blood was observed. It was found that chewing caffeinated gum for 5 minutes effectively absorbed 85% of the caffeine, and chewing for 10 minutes almost completely absorbed all the caffeine in the gum. In terms of blood concentration, the highest concentration of caffeine in the blood occurred after 15 minutes of chewing caffeinated gum (12). For exercise performance, chewing gum containing 100-300 mg of caffeine 5-15 minutes prior to exercise can be effective in enhancing aerobic capacity, decreasing decline in sprint speed, increasing vertical jump height, and improving explosive power (13-15). However, it is still unclear whether it can also improve basketball-specific fitness and technical skills.

Flywheel eccentric exercise is a form of eccentric training. During exercise, the speed of the flywheel increases when the muscles contract centrally, which causes the flywheel to give resistance when the muscles contract centrally, thus achieving the effect of eccentric contraction training (16). For basketball players, Xie et al. (2022) used 12 collegiate basketball players as participants in this study. After performing flywheel inertial resistance exercise, they found that there was better post-activation and a significant increase in vertical jump height and training intensity for high intensity training compared to traditional weight training(16). Brien (2020) recruited 20 basketball players to perform 4 weeks of flywheel inertial resistance exercise training. The results of the study showed that inertial resistance exercise on the flywheel was effective in improving neuromuscular recruitment, sprinting speed, and jumping height

(17). In addition, in a study by Suarez-Arrones et al. (2020), it was found that better explosive power was significantly and positively correlated with better vertical jump height and sprint speed when using a flywheel inertial resistance exercise device for performing the squat exercise (18). Thus, it seems that the measurement of explosive power during squats by inertial resistance exercise device may be one of the indicators to explore basketball-specific athletic ability.

Caffeine supplementation has been shown to be effective in enhancing ball sports performance; however, it remains unclear whether chewing caffeine has the same significant effect on basketball-specific athletic ability. Furthermore, Flywheel inertial resistance exercise device has been found to have significant reliability for explosive power testing (19). Better explosive power output has been found to have a significant positive correlation with sprint speed and vertical jump height. Whether chewing caffeinated gum also significantly enhances energy output in flywheel inertial resistance exercise may have a significant effect on better basketball-specific athletic performance. Therefore, the purpose of this study was to investigate the effect of caffeine chewing gum on basketball-specific exercise performance.

Methods

Methods

Design

The study was a double blind, repeated-measure, crossover design where participants were randomized to chewing 3 mg/kg of caffeinated gum (CAF) and a placebo gum (PL) separated by 7 days. At least 1 week before the formal experiment, all participants performed in one to two familiarization tests. The primary outcome was the results of the goal percentage of stationary free throw, and the secondary outcome were basketball-specific physiological tests. This study was start from 01/08/2023 to 31/08/2023.

Participants

Fifteen healthy adult male basketball players were enrolled in this study. Inclusion criteria were: 1. 6 years of professional basketball training and with at least a top 8 national ranking 2. 6 months of continuous training, and 3. 3 months of recovery from sports injuries such as strains and sprains. Exclusions criteria were: 1. Non-specialized basketball players. 2. has not trained regularly for the past 6 months. 3. has recovered from from a sports injury for less than 3 months, or had epilepsy, hypertension, hyperlipidemia, heart disease, arthritis, osteoporosis, brain injury, or a history of caffeine allergy. 4. Subjects with previous caffeine allergy response. All subjects will be given a fully explanation of the possible risks involved in the experiment before the experiment and a signed consent form will be given after obtaining the subject's consent. Two weeks before the experiment, subjects were asked to minimize their caffeine intake to less than 80 mg a day. This study received approval from the Institutional Review Board of Jen-Ai Hospital - Dali Branch (111-83). This study was conducted following the Declaration of Helsinki.

Protocol

Experimental procedure

All participants were required to take the same test 1-2 times before the main test to familiarize themselves with the content of the main test. On the day of the main experiment, the same breakfast and lunch will be provided to the participants to ensure that they have the same energy intake before the test. On the day of the formal experiment, participants had breakfast and lunch at 8:00 a.m. and 12:00 p.m., respectively. The nutritional composition of breakfast and lunch was 11.9±2.4% protein, 416±16.7% carbohydrate, 26.8±6.1% lipid, and1353.6±135.4 kcal. Two weeks prior to the trial, participants will also be asked to avoid caffeinated beverages and foods as much as possible.

All experiments started at 3:00 pm. After arrival at the stadium, the participants took a 10-minute quiet rest. After resting, the participants warmed up dynamically according to their own customary warm-up method. After warming up, they performed 15 meter sprints, 4 times in total, followed by 10 squat jumps. Warm up time is about 10-15 minutes. After warming up, the participants chewed caffeinated gum containing 3 mg/kg of caffeine (CAF trial) or a non-caffeinated placebo gum (PL trial) for 10 minutes in both trials. The chewing time was based on a previous hemodynamic study that found that chewing caffeinated gum for 10 minutes allows the body to fully absorb the caffeine in the gum (12). While chewing the gum, the participant can warm up with

a free-throw shooting program. After chewing, the gum was spit out and rested quietly for 15 minutes. In pervious studies, chewing caffeine gum for 15 minutes prior to exercise has been found to be effective in maximizing blood concentration (12). and improving sprint speed, vertical jump height, and explosive performance (13-15). After the rest, participants performed the stationary free throw shooting test, countermovement jump, t-test, 20-meter segmented dash test, squat in the flywheel device and running based anaerobic sprint test in sequence. All tests are expected to be completed within 45 minutes.

Outcome measure

In the stationary free throw shooting test, the participant takes 3 sets of free throws, making sure that the participant does not violate the penalty line during the entire test. Each group takes 10 goals, with a 1-minute break, and the number of goals scored is recorded.

The countermovement jump test was performed using a jumping mat (Fusion Sport, Coopers Plains, QLD, Australia). The participant stands on the jumping mat and stays as still as possible, jumping with his hands on his hips without swinging. After hearing the tester's instruction, the participant quickly squatted down until the knees were bent at a ninety-degree angle, and then jumped vertically as quickly as possible,

allowing the feet to return to the jumping mat at the same time as a cushion. A total of 3 jumps were performed and the average height was analyzed.

The T-shaped agility test is a common agility test method (20). The four corner vertebrae were set up in a T-shape and the timing light gate (Witty, Microgate, Bolzano, Italy) was set at the starting position with an accuracy of 0.01 seconds. The participants sprinted 10 yards from the first vertebrae to the second vertebrae with the fastest speed, then did a left side step for 5 yards to the third vertebrae, then a right side step for 10 yards to the fourth vertebrae and then immediately did a left side step for 5 yards back to the second vertebrae, and then finally returned to the first vertebrae and ended the timer and test by running backwards. During the test, the participants must touch the vertebrae with his hand before moving to the next target vertebrae.

The 20-meter segmented sprint test is conducted using a timing grating (Witty, Microgate, Bolzano, Italy), which is placed at the starting point, 10 meters and 20 meters. The participants complete a 20-meter straight line as fast as they can, two times in total, with a 2-minute break each time. The average completion time was recorded.

The flywheel inertial resistance exercise test consists of 3 sets of 5 repetitions on an inertial resistance trainer (K-Box 4, Exxentric, Stockholm, Sweden) using a Harness Squat (21). The participants wearing an orthopedic undershirt, stepped onto the inertial resistance machine, adjusted his center of gravity to the center of the machine, and set

the counterweights on the underside of the machine and fastened them. After the test, the participants were instructed to squat as hard as possible until the thighs were parallel to the ground. Complete five repetitions of the squat, and record the average power, peak concentric force and peak eccentric power of the squat.

The anaerobic sprint test, which consists of six 35-m maximal effort sprints with a 10-second rest between sets, measures peak power, mean power, minimum power, and fatigue index. It has been shown to have adequate reliability (22). The first time gate was placed at the starting position and the second time gate was placed at the 35m end point, with a sufficient distance for a 10 second buffer. After the participants were familiarized with the test procedure, they could start to prepare for the test. When the participants is ready, he stays still and completes six 35-meter sprints at maximum effort, with a 10-second break between each sprint. The time of completion of each sprint was recorded for subsequent analysis.

Caffeine and placebo gum

The caffeinated chewing gum used in this study (Military Energy Gum, Arctic Mint flavor; Stay Alert, Chicago, USA) has been used in previous studies (23). Each piece of gum contains 100 mg of caffeine in approximately 5 g of gum. The placebo gum used was a commercially available blue mint gum. In order to provide 3 mg of

caffeine per kilogram of body weight and to achieve a double-blind effect, all chewing gums will be mashed, ground, homogenized, and reshaped with 0.3 g of peppermint flavoring powder, and will be similar in color, appearance, taste, weight, and size. All chewing gums were prepared by specialized personnel and given to the on-site testers after numbering. After chewing the gum, a questionnaire was given to the subjects to confirm whether they could tell the difference between the two chewing gums. In the CAF trial, 8 out of 14 (57%) participants incorrectly guessed whether the gum contained caffeine or not. In the PL trial, 6 out of 14 (42%) participants incorrectly guessed whether the gum contained caffeine or not.

Statistical analysis

All data are presented as averages ± standard deviations. The Shapiro–Wilk test was used to examine the normality of the data. The result of stationary free throw shooting test, countermovement jump, t-test, 20-meter segmented dash test, squat in the flywheel device and running based anaerobic sprint test were analyzed through a paired sample t test. We used G*power 3 software 24 to achieve an alpha value of 5%, effect size of 1 and a power of 0.8; a sample of 12 was considered sufficient for this study. All data were calculated using SPSS (version 20, Chicago, IL, USA), and the significance level was $\alpha < 0.05$.

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