Effects of caffeinated chewing gum on 400-meter performance and fatigue index of sprinters: a crossover trial

Document Date: May 23, 2024

Project summary

The purpose of this study was to investigate the effect of caffeinated chewing gum on 400-meter sprint performance. Methods: Eight trained sprinter were divided into caffeine Gum trial (CAF) and Placebo trial (PL) with a randomized, double-blind study design. The participants chewing either caffeine Gum (CAF trial, containing 3 mg/kg of caffeine) or Placebo Gum (PL) for 10 minutes. After rested for 15 minutes, the participants underwent a Running-Based Anaerobic Sprint Test. After a 30-minute break, a 400-meter sprint test was performed. The blood lactate concentration were collected before and after 400-meter sprint from finger. Saliva samples were predicted to be collected before chewing gum, before the RAST, and after a 400-meter sprint. Saliva samples will be analyzed for caffeine and α–amylase concentrations in saliva.

Introduction

Many athletes use caffeine (1, 3, 7-trimethylxanthine) as a nutritional supplement, which is widely available in everyday foods such as coffee, chocolate, tea, cola and energy drinks. Caffeine intake can reduce fatigue by inhibiting adenosine receptors, increase the ability of the sarcoplasmic reticulum to release calcium ions, maintain sodium-potassium ATPase activity, and increase glycolysis before exercise(1, 2), all of which are mechanisms that can significantly increase sprinting speed (3), repetitive sprinting ability, and maximal muscular strength and explosive power (4). These increases in physical performance may be effective in improving athletic performance. Previous studies have shown that a pre-exercise caffeine intake of 3-6 mg per kilogram

of body weight can achieve the highest concentration in the bloodstream one hour after intake (5, 6), resulting in performance enhancement. However, caffeine is slowly absorbed in the gastrointestinal tract and may cause gastrointestinal discomfort or excessive fluid intake (8). Finding alternative forms of caffeine supplementation may reduce gastrointestinal discomfort.

Caffeine supplementation using caffeinated gum before exercise has been found to be absorbed through the oral mucosa at a faster rate than caffeine capsules (7). In a study by Morris et al. in 2019, test subjects chewed gum containing 100 mg of caffeine for 2, 5, and 10 minutes to observe their caffeine absorption rate and blood levels. The results showed that 85% of the caffeine was effectively absorbed after 5 minutes of chewing caffeinated gum, and after 10 minutes, the caffeine in the gum was almost completely absorbed. In terms of blood concentration, the highest concentration of caffeine (8) was observed after 15 minutes of chewing caffeine gum. In terms of exercise performance, chewing gum containing 100-300 mg of caffeine 5-15 minutes before exercise can effectively improve aerobic capacity, slow down the decline of sprinting speed, increase vertical jump height, and enhance the effect of explosive power (9, 10).

Caffeine supplementation has been shown to be effective in enhancing exercise performance; however, it remains unclear whether chewing caffeine has the same significant effect on 400-meter spirting. Therefore, the purpose of this study was to investigate the effect of caffeine chewing gum on 400-meter spirting exercise performance and fatigue index.

Methods

Design

This study used a randomization crossover design with double-blind experimental design. Participants will be divided into a caffeinated chewing gum trial (CAF) and a placebo trail (PL). The placebo trail (PL). After the first trial, the participants rested and recovered for 7-10 days before the next trial, which was expected to be completed within one month. During the trial period, all participants maintained their normal training status, with no changes in training or retraining menus, and no over-training or extra competitions.

Participants

In this study, 15-20 healthy adult male sprinters were recruited as participants. Inclusion criteria were: 1. 6 years of professional short sprinting training, 2. 6 months of ongoing training, and 3. 3 months of recovery from sports injuries such as strains and sprains. Exclusions: 1. Non-specialized sprinters. 2. has not trained regularly for the past 6 months. 3. has recovered from an athletic injury. 4. less than 3 months of recovery from a sports injury, or participants with epilepsy, hypertension, hyperlipidemia, heart disease, arthritis, osteoporosis, brain injury, or a history of caffeine allergy. According to the results of last year's National Academy of Sciences program, caffeinated gum was found to have an effect on the fatigue index of basketball players with Cohen's d = 1.00. The effect was measured using the G*POWER statistical software, with the POWER value set to 0.8, it was found that eight participants were sufficient to explain the validity of the study data. In order to achieve a more precise POWER value, the number of participants in this study was set at 15-20. All participants were fully explained the experimental procedure and informed of the possible risks before the experiment. This study received approval from the Institutional Review

Board of Jen-Ai Hospital - Dali Branch (202300071B0). This study was conducted following the Declaration of Helsinki.

Protocol

Experimental procedure

All experiments were scheduled to start at 3:00 pm. Upon arrival at the stadium, participants were fitted with a heart rate monitor (RS800; Polar Electro Oy, Kempele, Finland) to record their quiet heart rate and heart rate variability. This heart rate meter has been found to have very good reliability in measuring heart rate variability during exercise (11). After the heart rate meter is attached, the saliva of the participant is collected and analyzed for biochemical parameters. At the same time, a fingertip blood sample was taken to analyze the blood lactate concentration in the quiet state. After a 10-minute rest period, the participant will start a dynamic warm-up and record the content of the warm-up, and use the same warm-up content in the next experiment. After the warm-up, participants chewed caffeine gum (4 mg/kg for 10 minutes each time) or placebo (regular gum for 10 minutes each time) and rested for 15 minutes after the chewing. Before and after the 400-meter test, saliva samples and fingertip blood were taken again for subsequent biochemical and blood lactate analyses. After completing the first experiment, we rested for 7 days and then proceeded to the second formal experiment. Both experiments were completed within one month.

Outcome measure

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 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 (12). 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.

The 400-meter segmented sprint test is conducted using a timing grating (Witty, Microgate, Bolzano, Italy), which is placed at the starting point, 100 meters, 200 meters, 300 meters and 400 meters.

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 (13). 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 4 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.

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 were analyzed through a paired sample t test. All data were calculated using SPSS (version 20, Chicago, IL, USA), and the significance level was $\alpha < 0.05$.

Reference

1. Kalmar JM. The influence of caffeine on voluntary muscle activation. Medicine and science in sports and exercise. 2005;37(12):2113-9.
2. Davis JM, Zhao Z, Stock HS, Mehl KA, Buggy J, Hand GA. Central nervous system effects of caffeine and adenosine on fatigue. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology. 2003;284(2):R399-R404.
3. Beaven CM, Maulder P, Pooley A, Kilduff L, Cook C. Effects of caffeine and carbohydrate mouth rinses on repeated sprint performance. Applied Physiology, Nutrition, and Metabolism. 2013;38(6):633-7.
4. Trexler ET, Smith-Ryan AE, Roelofs EJ, Hirsch KR, Mock MG. Effects of coffee and caffeine anhydrous on strength and sprint performance. European journal of sport science. 2016;16(6):702-10.
5. Chia JS, Barrett LA, Chow JY, Burns SF. Effects of caffeine supplementation on performance in ball games. Sports Medicine. 2017;47(12):2453-71.
6. Tan ZS, Sim A, Kawabata M, Burns SF. A systematic review of the effects of caffeine on basketball performance outcomes. Biology. 2021;11(1):17.
7. Kamimori GH, Karyekar CS, Otterstetter R, Cox DS, Balkin TJ, Belenky GL, et al. The rate of absorption and relative bioavailability of caffeine administered in chewing gum versus capsules to normal healthy volunteers. International journal of pharmaceutics. 2002;234(1-2):159-67.
8. Morris C, Viriot SM, Mirza QUF, Morris GA, Lynn A. Caffeine release and absorption from caffeinated gums. Food & function. 2019;10(4):1792-6.
9. Guest NS, VanDusseldorp TA, Nelson MT, Grgic J, Schoenfeld BJ, Jenkins ND, et al. International society of sports nutrition position stand: caffeine and exercise performance. Journal of the International Society of Sports Nutrition. 2021;18(1):1.
10. Ryan EJ, Kim C-H, Fickes EJ, Williamson M, Muller MD, Barkley JE, et al. Caffeine gum and cycling performance: a timing study. The Journal of Strength & Conditioning Research. 2013;27(1):259-64.
11. Hernando D, Garatachea N, Almeida R, Casajus JA, Bailón R. Validation of heart rate monitor Polar RS800 for heart rate variability analysis during exercise. The Journal of Strength & Conditioning Research. 2018;32(3):716-25.
12. Zagatto AM, Beck WR, Gobatto CA. Validity of the running anaerobic sprint test for assessing anaerobic power and predicting short-distance performances. The Journal of Strength & Conditioning Research. 2009;23(6):1820-7.
13. Ranchordas MK, King G, Russell M, Lynn A, Russell M. Effects of caffeinated gum on a battery of soccer-specific tests in trained university-standard male soccer players. International journal of sport nutrition and exercise metabolism. 2018;28(6):629-34.