Effect of Carbohydrate Rinsing and Caffeine Gum Intervention on Performance of Romanian Deadlifts on Flywheel Training Device

Project summary

We explored the effect of Carbohydrate Rinsing and 200mg of caffeine caffeine gum chewing on the performance of romanian deadlifts on flywheel training device. We recruited 20 healthy adult men who in this study. In study 1, participants were randomly allocated to the Carbohydrate Mouth Rinsing (CMR) and placebo (PL) groups. In study 2, participants were randomly allocated to the caffeine gum chewing (CG) and placebo (PL) groups and subjected to a crossover experiment in which they performed maximum inertial resistance training comprising five sets of six reps, with 3-min rests between sets. After deducting the first repetition of each sets, the mean values from the five sets were analyzed.

General information

Protocol title: Effect of Carbohydrate Rinsing and Caffeine Gum Intervention on Performance of Romanian Deadlifts on Flywheel Training Device (Date: 18/03/2022; ID: NA)

Funder: This study was funded by Ministry of Science and Technology in Taiwan (106, Sec. 2, Heping E. Rd., Taipei 10622, Taiwan).

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Introduction

In the early 20th century, carbohydrates were discovered to be a crucial source of energy for exercise(1). During prolonged endurance exercise, carbohydrate intake helps maintain blood glucose concentrations, exercise reaction times, and technical performance(2, 3). However, even during shorter, higher-intensity exercise (e.g., < 1 hour, 75% $\dot{V}O_2max$), carbohydrate intake can improve exercise performance(1). For this reason, muscle glycogen depletion is not considered a performance-limiting factor, and other factors may enhance performance during high-intensity exercise(4).

Studies have had participants gargle an aqueous solution of CHO in the oral cavity for several seconds and spit it out. This method was associated with improved performance during endurance activities(5). During mouth rinsing, the CHO in the aqueous solution travels to the neural sensors in the oral cavity, which improves the performance of the nerve signals transmitted to the brain; this provides indirect evidence of the strengthening of the central nervous system effect(4). Rinsing the mouth with CHO solution and then spitting it out can also prevent gastrointestinal discomfort caused by the ingestion of CHO and the conflict between improving sports performance and the ingestion of CHO for those with weight control needs; this method also provides new reference for the supplementation of CHO in sports performance.

A study on aerobic exercise conducted a long-distance cycling test after participants gargled a 6.4% CHO solution. During exercise, the average power, overall power, and climbing power increased, and perceived levels of fatigue decreased(6). However, studies on the effects of CHO-solution mouthwashes on short-term, high-intensity exercise and resistance training have yielded inconsistent results. Decimoni et al. (2018) discovered that rinsing the mouth with a CHO solution before resistance exercise can reduce fatigue and enable weightlifters to lift heavier loads during resistance exercise(7). However, another study observed that gargling different doses of CHO solution (6%, 12%, and 18%) before resistance exercise did not improve maximal muscle strength or muscle endurance(8). Whether rinsing the mouth with CHO solution before resistance exercise improves performance remains to be further explored. On the other hand, it remains to be studied whether chewing caffeinated gum can also enhance inertial resistance exercise performance.

Flywheel resistance training, a type of eccentric load training, has been widely discussed and used for various sports. In flywheel resistance training, inertial power generated by the flywheel during muscle acceleration and deceleration provides resistance in the eccentric and concentric phases, respectively(9). The flywheel has been demonstrated to improve health and athletic performance and prevent sports injury(10). No studies have examined the effect of rinsing the mouth CHO solution on the performance of inertial resistance exercise. For this reason, this study investigated the effect of carbohydrate mouth rinsing (CMR) on inertial resistance exercise performance.

Methods

Participants

This study recruited 20 healthy adult men (age: 22.4±3.7yr, height: 171.3±5.9cm, weight: 76.4±11±kge). The inclusion criteria were (1) regular weight training habits, (2)

familiarity with Romanian deadlift movements, and (3) no chronic diseases such as hypertension, diabetes, and kidney disease or sports injuries such as lacerated knee ligaments, inflammation and rupture of tendons, strained biceps femoris or quadriceps, and strained biceps within the 6 months prior. Those who (1) did not have regular exercise habits, (2) were unfamiliar with Romanian deadlift movements, and (3) had certain health problems that prevented them from performing exercise or injury from which they had not recovered for more than 6 months were excluded. Before the experiment, the researchers explained the experimental procedure to the participants and obtained their informed consent. This study was approved by the Human Subject Research Ethics Committee of Jen-Ai Medical Foundation (111-09). This study was conducted in accordance with the Declaration of Helsinki.

Experimental design in study 1

This study conducted a randomized crossover trial with a single-blind experimental design. All participants were subjected to two experimental conditions, one with CMR and a placebo trial (PL). The CMR was a colorless and odorless 6.4% maltodextrin solution, and mineral water was used for the PL. After at least two introductory sessions, the participants were randomly divided into two experimental sequences, CMR-PL or PL-CMR, by using a crossover design. The second phase of the experiment was held after 7 days of rest and recovery to eliminate the effects of muscle fatigue and delayed muscle soreness.

Experimental design in study 2

This study conducted a randomized crossover trial with a single-blind experimental design. All participants were subjected to two experimental conditions, one with CAF and a placebo trial (PL). The CAF was chewing the caffeinated gum containing 200 mg for 20 minutes, and placebo gum was used for the PL. After at least two introductory sessions, the participants were randomly divided into two experimental sequences, CAF-PL or PL-CAF, by using a crossover design. The second phase of the experiment was held after 7 days of rest and recovery to eliminate the effects of muscle fatigue and delayed muscle soreness.

Pretests

Two pretests were conducted before the formal experiment. The pretests involved familiarization with the experimental apparatus, practicing the movements, and testing with different inertia loads. The load resistance was 0.010, 0.025, 0.050, or 0.075 kg, and the participants' peak power was used as the experimental load resistance. The

pretests were separated by 7 days, and the first phase of the formal experiment and the last pretest were also separated by 7 days to allow for adequate recovery of muscle performance.

The participants used an Exxentric inertial resistance training machine (Exxentric kbox 4 Pro, Stockholm, Sweden) to complete the Romanian deadlift movement test. With the maximum inertial resistance measured during the pretest being used as the resistance load during the experiment, the participants underwent maximum inertial resistance training comprising five sets of five reps, with a 3-min rest between.

The second pretest involved the same procedure as the first pretest but with the participants using the load resulting in the highest power output identified during the first pretest; the pretests were conducted at least 48 h apart. Before each test, the participants underwent a standardized warm-up supervised by the individual conducting the experiment, which included riding on a stationary bicycle with a speedometer for 5 minutes (at a manageable intensity, that is, in the 10–12 range on the perceived exertion scale, with the full range being 6–20), a joint range of motion warm-up, and dynamic stretching for 3 min. Before the warm-up, the scale was explained.

Formal experiment

The participants were required to arrive at the laboratory at 3:30 p.m. on the day of the experiment, fast for at least 3 hours beforehand, and avoid high-intensity training (e.g., weight training, endurance training, and high-intensity interval training) for 3 days before the experiment. All groups were required to consume the same food 24 hours before the experiment and avoid caffeine, alcohol, energy drinks, and any form of stimulant or other substance that would affect exercise performance.

Before the first experiment, the participants performed a standardized warm-up, comprising riding on a stationary bicycle for 5 minutes, joint range of motion warm-up and dynamic stretching for 3 min, and one set of eight reps of Romanian deadlifts with the flywheel; the load resistance was 0.01 kg. The participants rinsed their mouths with either 25 ml of CHO solution or the placebo solution for 20 seconds and spit the solution into a designated container after rinsing. Next, the participants used the inertial resistance training machine to complete the Romanian deadlift movement test. With the maximum inertial resistance measured during the pretest being used as the resistance load during the experiment, the participants completed maximum inertial resistance training comprising five sets of five reps, with a 3-min rest between. A 0.6-kg training bar was attached to the inertial resistance training machine during each testing session. To standardize the participants' range of motion during testing, a piece of tape was placed at the midpoint between the tibial trochanter and talus to indicate the range of

motion for the Romanian deadlifts, with the endpoint being full hip extension. The process was as follows:

1. Participants stood over the tether with their feet hip-width apart, toes pointing forward, and head and eyes facing straight ahead.
2. Hands were positioned shoulder-width apart, naturally lowered, with a positive grip on the training bar.
3. The training bar was connected to the tether, which was connected to the flywheel shaft through a hole in the platform, and the movement began in the bent position (i.e., at the designated starting point of the range of motion). The participants pushed back on their gluteus maximus and kept their back straight, their shoulders pulled back, and their chest up.
4. Each movement started with the concentric phase and ended with the eccentric phase.
5. In the concentric movement phase, the crossbar was pulled along the thigh, and the tether was pulled to put the flywheel in motion. Participants contracted the gluteus maximus, hamstrings, and lower back muscles until the hip joint was fully extended to the end position.
6. During the eccentric movement stage, the flywheel rotated, and the motion decelerated from the end position through centrifugal muscle contraction. Participants then completed the motion and returned to the starting position through a braking motion.
7. These steps were repeated until the test was complete.
8. The participants were instructed to not shrug their shoulders when their hip joints were fully extended and not allowed to flex their ankles.
9. The participants began resisting the inertia in the first third of the concentric movement and then stopped moving at the end of the range of motion with maximum effort; the participants were instructed to perform the concentric movements quickly.

Before each set, participants performed one test movement to increase the power of the flywheel, followed by five test movements, and they were verbally encouraged throughout the test. These initiated the movement of the flywheel and increased its speed, and the resulting data were excluded from statistical analysis. In the second experiment, which was conducted 7 days later, the participants repeated the steps from the first experiment.

The participants' test data were measured using Kmeter, fed back to the system, and transferred to an Android device (ASUS ZenFone 6) over Bluetooth for storage. The data were then exported to a computer in comma-separated value format for statistical analysis. The researchers analyzed data on seven factors measured using the Kmeter feedback system: power, concentric peak power, eccentric peak power, average force, average speed, peak speed, and total work.

Carbohydrate solution and placebo

In the experiment, the carbohydrate solution was prepared by dissolving 6.4 g of colorless and odorless maltodextrin in 93.6 mL of water; the mixtures were then adjusted to a 6.4% maltodextrin solution for the participants to rinse their mouths; the placebo group rinsed their mouths with drinking water. All carbohydrate solutions were prepared by the principal investigator of the research project before the experiment, and they were similar to the placebo in appearance and taste to ensure that the participants could not distinguish them. Mouth rinsing was defined as distributing the carbohydrate solution around the mouth for a few seconds followed by spitting it out into a designated container. The most commonly used carbohydrate solutions are glucose and water-soluble maltose dextrin at a 6.4% concentration(11), which are used for 15–20 seconds before exercise. Thirteen participants correctly guessed they were on carbohydrate (65%) and nine participants correctly guessed they were on placebo (45%).

Caffeine gum

The experimental group of caffeine gum will use the U.S. Army's caffeine gum (Military Energy Gum-StayAlert, Arctic Mint flavour; Chicago, IL) as the experimental group. Caffeine gum contains 100mg of caffeine.

Exxentric kbox 4 Pro

Many studies have described the mechanical advantages of flywheel devices and their effects on neurophysiological mechanisms, muscle morphological adaptation, and training during acute and chronic conditioning(12); this has stimulated an interest in the benefits of flywheel exercise in athletic training, injury prevention, and clinical rehabilitation among researchers and practitioners(13).

In inertial resistance training, flywheel inertia is used to generate eccentric force, enabling eccentric muscle training. The muscle groups that can be trained through this method include the triceps, biceps, gluteus maximus, quadriceps, back, and calves. Data on at least five factors (average power, concentric peak power, eccentric peak power, overload peak, and average force) can be measured using the Kmeter feedback system and presented as a bar graph in the app. The system can also be used to measure displacement distance, average speed, peak speed, total work (in joules), number of reps, and average rep time.

Statistical analysis

The data are presented as means ± standard deviations, and the analysis was performed using SPSS (version 20, Chicago, IL, USA). The Shapiro–Wilk test was

conducted to test the normality of the data. Paired-samples t-test was used to compare the average power, concentric peak power, eccentric peak power, average force, average speed, peak speed, and total work in the five Romanian deadlift sets between the CMR and PL groups. The before-and-after differences in heart rate and rating of perceived exertion (RPE) were analyzed using a repeated sample two-factor analysis of variance. Significance was $\alpha < 0.05$.

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