Carbohydrate mouth rinsing and softball batting performance: a double-blind crossover study

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Project summary

Carbohydrate mouth rinsing (CMR) stimulates the central nervous system and improves motor control. However, no studies have examined the effects of CMR on softball batting performance. The purpose of this study was to investigate the effect of CMR on softball batting performance. Fourteen trained collegiate female softball players (age: 20.6±0.9 years; height: 159.5±5.2 cm; body weight: 58.1±6.9 kg) completed two trials in a randomization crossover trail, in which they rinsed their mouths for 20 seconds with 25 ml of either 6.4% maltodextrin (CMR) or placebo (PLA). After rinsing, the grip force, counter-movement jump (CMJ) and batting tests were performed in sequence. The tanner tee was utilised to perform five sets of five balls at a time, with a minimum of 3 minutes rest between sets. The batting test recorded average exit velocity, maximum exit velocity and batting accuracy. The standardized standard deviation (SD) for launch angle represents standardized variability.

Introduction

Many studies have found that pre-exercise carbohydrate supplementation is effective in maintaining high levels of glycogen in muscle and improving endurance performance in activities exceeding an hour in duration (1, 2). However, since Carter et al. (2004) revealed that the use of a carbohydrate mouth rinsing (CMR) still had a significant effect on improving athletic performance over a shorter period of time(3), it has been shown that CMR not only improves endurance performance over a short period of time, but also has a significant effect on high intensity exercise (4), improves resistance training quality (5), muscle strength of the lower limbs (6) and decrease fatigue index during intermittent exercise(7). The potential mechanism may be due to the delaying of fatigue in the central nervous system (8) and may facilitate the activation of the brain regions associated with exercise control(9). It has been proposed that the mechanism of CMR involves the activation of the dorsolateral prefrontal cortex and the ventral striatum (10). The cerebral cortex is integral to cognitive, attentional processing, and motivation (11). The aforementioned phenomena suggest that CMR is not only beneficial for endurance sports but also enhances performance in explosive sports and improves body control during exercise.

In the context of fast pitch softball, enhancing both batting exit velocity and bat control represents a crucial strategy for increase the score and win rate of the game(12). In each swing, it is necessary to combine speed and explosive power. This can be achieved through the use of lower extremity forces, which are employed to transfer weight from the lower to the upper body. The rotation of the torso at a rapid pace also serves to increase the speed of the swing (13). It has been suggested that increase the muscle strength and explosive power of as important factors for improving the exit velocity of the ball for female softball players(14). Previous research has demonstrated the efficacy of CMR in enhancing lower limb strength, explosive power (6), and potentially cognitive function (11). From these perspectives, CMR appears to be a promising approach for enhancing both exit velocity and batting control.

CMR has positive effects on athletic performance and activates areas of the brain related to motor control (9). For softball batting, an increase in batting speed and stable control of the angle of elevation of the bat will improve batting performance and thus increase the team's chances of winning. However, there are no studies that have examined the effect of CMR on batting performance in softball. Therefore, the purpose of this study was to investigate the effect of CMR on the exit velocity and bat control of female softball players.

Methods

Experimental Design

This study was conducted using a single-blind randomized cross-over experimental design, whereby all participants were required to complete two trials. The carbohydrate mouth rinsing trial (CMR) utilised a colourless and odorless water solution, comprising 6.4% maltodextrin. The mineral water was utilised for the placebo trial (PLA). For each rinsing, 25ml of the water solution was used, and the rinsing process was conducted for 20 seconds before the solution was spat back into the original cup. After completing the first experiment, the participant rested for at least 7 days and completed the next experiment.

Participants

A total of 15 female collegiate fast-pitch softball players were recruited for this study. Following the withdrawal of one participant due to personal reasons, the final results of 14 participants (mean age: 20.6 ± 0.9 years; height: 159.5 ± 5.2 cm; mass: 58.1 ± 5.9 kg; mean training age: 6.8 ± 0.8 years) were analysed. The inclusion criteria for this study were: (a) more than 6 years of professional fast-pitch softball training; (b) more than 6 months of continuous training; (c) from at least the top four teams in the country.. The exclusion criteria were: (a) non-professionally fast-pitch softball training; (b) lack of regular training in the past 6 months; (c) in the event that the applicant has sustained a sports injury or is currently experiencing epilepsy, hypertension, hyperlipidemia, heart disease, arthritis, osteoporosis, or a brain injury, and has yet to undergo a period of recuperation exceeding three months. All participants signed the consent form after being informed of the procedure and the associated risks prior to the experiment. All tests were completed during non-menstrual periods. The study was approved by the institutional review board of China Medical University Hospital, Taiwan (CMUH110-REC2-253). This study was conducted following the Declaration of Helsinki.

Sample size calculation

We used G*Power software (version 3.1.9.4, Universität Düsseldorf, Germany) (15) to determine the required sample size. The calculation was based on an alpha level of 0.05 and a correlation coefficient of 0.80, which were deemed to be the appropriate levels for the purposes of this study. A previous study demonstrated that CMR enhances lower limb muscle strength, with an effect size of 0.56 (6). The analysis revealed that a sample size of 14 would be sufficient for the purpose of detecting a difference between trials. A sample size of 14 participants should be sufficient to elucidate the statistical discrepancies.

Protocol

The formal examination comprises grip strength assessments, CMJ and batting tests. It is imperative that all participants undergo familiarisation tests on at least two occasions prior to the formal test. Three days prior to the first formal trial, participants were asked to photographically record the contents of all meals as well as the time of consumption. In the next formal experiment, participants were asked to eat exactly the same food at the same consumption time. On the day of the experiment, after a standard lunch at 12:00, arrive at the laboratory at 15:30 for the experiment.

After a five-minute break, the participants were free to warm up dynamically. All warm-up movements and times were recorded and the same movements were used for the next warm-up. After warming up sufficiently, the participant performs the first rinsing, which is followed by a maximum grip strength test with the dominant hand. Perform a total of 3 sessions with a 1-minute break between each session. Following the completion of the grip strength test, the participant was permitted a three-minute period of rest. Subsequently, they rinsed their mouth and proceeded to undertake the CMJ test on 3 occasions, with a one-minute interval between each attempt. In previous studies, a positive correlation has been identified between grip strength, jump height and the exit velocity of a ball in baseball players (16). After completing these tests, participants underwent a 5-minute dynamic warm-up of batting. The tanner tee was utilised to perform five sets of five balls at a time, with a minimum of 3 minutes rest between sets. Participants rinsed their mouths before each batting tests.

Outcome measure

In the grip strength test, the participant assumed a standing position with a standardised hand-held grip dynamometer (Smedlay's Hand Grip Dynamometer TTM, Japan) and adjusted the grip to the second knuckle, with the arm at an approximately 10° angle to the trunk. The participant was instructed to position the grip at an angle of between 0 and 15 degrees to the trunk and to press the grip continuously for approximately three seconds with maximum strength, maintaining stability of the trunk throughout the procedure. The procedure was repeated three times, with a one-minute rest interval between each repetition, and the resulting data were averaged (17).

A countermovement jump test was conducted utilising a jumping mat (Fusion Sport, Coopers Plains, QLD, Australia) to evaluate the participants. The participants were instructed to maintain a static standing position on the jumping mat with their arms

folded at the waist. Subsequently, the subjects were given instructions by the instructor and then maintained a position with their arms akimbo, before rapidly squatting to approximately 90° of knee flexion before performing a maximal vertical jump. The hip and knee joints were maintained in a extended position throughout the jump. Trials in which the knee was flexed to an angle of less than 90 degrees or in which the foot made contact with the ground were excluded from the analysis. Each participant completed three trials, with a one-minute interval between each trial. The mean value was then calculated (18).

In the batting test, the tanner tee is used. Place the tanner tee on the front edge of the center of the plate and adjust the height of the tanner teet to approximately the navel of the test participant. Set the batting target at a 10-degree angle, 10 metres in front of the plate, and ask the batter to hit each ball to the target, 5 swings per set, for a total of 5 sets. Hitting data is collected using Rapsodo Hitting 2.0 (Rapsodo Bassball System, Rapsodo Inc, Fishers, IN). This instrument has been employed in previous studies and has demonstrated sufficient reliability for the measurement of exit velocity and launch angle (19). Batting tests evaluate exit speed of the softball and launch angle, and calculated the standard deviation of launch angle, which is used as an indicator of batting consistency(19).

Statistical analysis

The data from this study were presented as mean ± standard deviation and underwent analysis using the statistical software package SPSS 23.0. The normality of the data was evaluated through the utilisation of the Shapiro–Wilk test. The data are presented according to a normal distribution, and a parametric methodology can thus be applied to statistical analysis. Paired samples t-tests were employed to ascertain the statistical significance of the observed differences in hand grip strength, countermovement jump, average batting exit velocity, maximum batting exit velocity and the SD of the launch angle. The significance level was set at $\alpha<0.05$.

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