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Effects of Ingesting Fat Free and Low Fat Chocolate Milk After Resistance Training on Exercise Performance

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by

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ABSTRACT

Collegiate athletes are always looking for ways to improve their performance. Resistance training has been incorporated into most collegiate athletic programs for this very reason. In order to improve strength, lean body mass, and exercise performance, resistance exercise and timely protein ingestion must be followed. Incorporating protein ingestion into a resistance training routine has been shown to improve net protein balance. Milk protein is gaining popularity as an ergogenic aid. There has been growing interest in the potential use of bovine milk (cow's milk) as an exercise beverage, especially during recovery from resistance training and endurance sports. No studies have been conducted comparing fat free chocolate milk and low fat chocolate milk on muscular strength and body composition in collegiate softball players.

The purpose of the present study was to investigate whether fat free chocolate milk and low fat chocolate milk ingested after resistance exercise improves common performance assessments of collegiate softball players. Specifically, the performance assessments were the vertical jump test, 20-yard sprint, and the agility t-test. The participants were randomized according to strength and bodyweight, in a double blind experimental design. The 18 female, collegiate softball players (18.5 ± .7 yrs; 65.7 ± 1.8

inches; 156.2 ± 21.6 kg) ingested either fat free chocolate milk or low fat chocolate milk immediately after resistance exercise workouts for an 8-week period. Dependent variables included vertical jump test, 20-yard sprint test and agility t-test. The data was analyzed via a paired samples t-test (to detect difference across both groups over the eight week training period) and an independent samples t-test (to detect differences between the groups) using SPSS for Windows 15.0. No statistically significant differences were found in the vertical jump, 20 yard sprint, or agility t-test between the fat free chocolate milk group and the low fat chocolate milk group.

The major, statistical, finding of this study is that the consumption of commercially available fat free chocolate milk versus low fat chocolate milk drink does not produce improvements in exercise performance in conjunction with an eight week periodized, resistance training program in collegiate softball players. The difference of 10 grams of fat (two servings per container) did not alter any of the performance variables (20 yard sprint, vertical jump or agility t-test).

Chapter One

Introduction

Collegiate athletes are always looking for ways to improve their performance. Resistance training has been incorporated into most collegiate athletic programs for this very reason (Kraemer et al., 2003). In order to improve strength, lean body mass, and exercise performance, resistance exercise and timely protein ingestion must be followed. Incorporating protein ingestion into a resistance training routine has been shown to improve net protein balance (Roy, 2008). Milk protein is gaining popularity as an ergogenic aid. An ergogenic aid is any substance that can increase physical or mental performance in any way. There has been growing interest in the potential use of bovine milk (cow's milk) as an exercise beverage, especially during recovery from resistance training and endurance sports (Roy, 2008; Shireffs, Watson & Maughan, 2007). Relative to resistance exercise, milk appears to be an effective post-resistance exercise beverage that results in favorable acute alterations in protein metabolism (Roy, 2008). Specifically, milk ingestion acutely increases muscle protein synthesis leading to an improved net protein balance (Roy, 2008; Elliot, Cree, Sanford, Wolfe, & Tipton 2006; Wilkinson et al., 2007). Further, when milk was ingested after resistance training for a 12-week period, it was reported that muscle fiber size and lean body mass were significantly increased in novice, male weightlifters (Hartman et al., 2007). Combined, these investigations (Roy 2008; Elliot, Cree, Sanford, Wolfe & Tipton, 2006; Wilkinson et al., 2007; Hartman et al., 2007) indicate that milk ingestion increases protein synthesis in the hours following a resistance exercise bout, and if milk ingestion following resistance training is practiced over a 12 week period, then increases in lean body mass are realized.

In most of the studies that assessed protein synthesis following milk ingestion and resistance exercise, fat free milk was used (Wilkinson et al., 2007; Hartman et al., 2007). Therefore, it was commonly believed that fat free milk was the best choice for increasing protein synthesis and lean body mass. However, a recent investigation compared the ingestion of fat free milk and whole milk one hour following a resistance exercise bout (Elliot, Cree, Sanford, Wolfe & Tipton, 2006). It was reported that those individuals that ingested the whole milk may have increased utilization of available amino acids for protein synthesis. What is needed at this point is to investigate if consuming milk with fat for several weeks is better than consuming fat free milk in terms of increasing lean body mass. If strength gains are realized, do they result in improvements in exercise performance related to softball? Therefore, the purpose of the present study is to compare the ingestion of fat free chocolate milk and chocolate milk containing fat following resistance training and to determine its effects on exercise performance in collegiate female softball players over an eight week period.

Purpose of the Study

The purpose of the present study will be to investigate whether fat free chocolate milk and low fat chocolate milk ingested after resistance exercise improves common performance assessments of collegiate softball players. Specifically, the performance assessments were the vertical jump test, 20-yard sprint, and the agility t-test.

Independent and Dependent Variables

The independent variables were the ingestion of 16 ounces of either fat free chocolate milk or low fat chocolate milk dairy drink that is commercially available. Dependent variables included vertical jump height, 20-yard sprint time, and the agility t-test.

Hypotheses

Ho_1: There will be no difference between the fat-free chocolate milk group and the low at chocolate milk group in the 20-yard sprint time.

Ho_2: There will be no difference between the fat-free chocolate milk group and the low at chocolate milk group in vertical jump performance.

Ho_3: There will be no difference between the fat-free chocolate milk group and the low at chocolate milk group in the agility t-test.

Chapter Two

Review of Literature

Milk as a Recovery/Rehydration Drink

Recently there has been growing interest in the potential benefits of consuming milk as an ergogenic aid. These interests focus mainly on milk as a post resistance training and endurance sport aid. There are different types of milk that may be consumed. Non fat, low fat, and whole milk are three milk beverages that have been studied. One of the reasons why milk is investigated as a rehydration beverage is that it contains electrolytes that aid in fluid replacements after exercise (Roy, 2008).

Shirreffs et al. (2007) investigated milk purely as a rehydration drink. Eleven subjects completed one practice trial and four experimental trials. The study compared low fat milk, low fat milk with added sodium, a traditional sports drink, and water. The trials were randomized and used the crossover method. The amount of drink that was consumed was equal to 150% of the volume of body mass lost during exercise. The total drinking time period was 60 minutes and was split evenly into 15 minute intervals. The milk that was consumed by the participants contained about 35 mmol/l of sodium which is thought to be a moderate amount and more than is in most sports drinks and water. The milk drink also contained approximately 45 mmol/l of potassium. Although potassium's rehydration role is not fully understood, it is known to be effective at restoring fluid balance (Shireffs, Watson & Maughan, 2007). As hypothesized by the researchers, milk was more effective as a rehydration drink than water or sports drinks. Urine output and fluid balance was measured over the course of the experiment. The subjects that consumed milk and milk with added sodium showed significantly less diuresis and greater drink retention. These subjects also remained in the euhydrated state until the end of the four hour recovery period.

Milk Proteins vs. Other Types of Protein

Some studies have also compared soy, whey, and bovine milk in relation to protein metabolism. Soy and whey are digested rapidly and referred to as fast proteins. Casein is considered to be the opposite, digesting slowly and causing a longer lasting rise in plasma amino acids (Boirie et al., 1997). Both milk and soy are high quality proteins (Young, 1991). In a review by Roy (2008) discussing milk as a sports drink it was concluded that low fat milk has two advantages in comparison to its competitors. First, it contains casein and whey proteins in a 3:1 ratio which causes slower digestion and absorption resulting in elevations of blood amino acid concentrations that are sustained longer. Second, whey has a large amount of branched chain amino acids that have an important function in muscle metabolism and protein synthesis.

Milk and Resistance Exercise Training

In order for muscle hypertrophy to occur during resistance exercise training, there must be an increase in muscle protein net balance. This net balance can be enhanced by combining resistance exercise with feeding (Biolo, Tipton, Klein & Wolfe, 1997; Borsheim, Tipton, Wolf & Wolfe, 2002; Tipton, Ferrando, Phillips, Doyle & Wolfe, 1999). Further research is needed to determine whether proteins from different sources induce a greater anabolic response after resistance exercise. The most common sources of supplemental protein include whey, soy, and casein (whey and casein are the two primary proteins found in milk).

Wilkinson et al. (2007) investigated the effects of nonfat milk versus soy protein on whole body and muscle protein turnover after resistance exercise. The subjects consisted of eight men who participated in resistance training four days a week or more. The subjects performed two resistance training routines separated by one week. Following the resistance training bout (consisting of seated leg press, prone hamstring curl, and seated leg extension) the subjects received either a milk or soy beverage. Following this acute bout of resistance exercise, it was reported that there was a significantly greater uptake of amino acids across the leg and a greater rate of muscle protein synthesis in the three hours after exercise with milk consumption as opposed to soy. Milk was also found to produce a more sustained net positive protein balance after resistance exercise than soy. There were no differences found in blood flow or insulin and blood glucose concentrations between the types of proteins. Amino acid levels were also found to be very similar. However, there are different digestion rates, where milk is slower and soy is more rapid (Bos et al., 2003). These digestion rates are thought to be responsible for the observed differences in net amino acid balance and rates of muscle protein synthesis.

Hartman et al. (2007) recruited 56 males to determine whether milk or soy is better for long term training and lean tissue gains. The subjects trained five days a week for 12 weeks using a split body resistance exercise program in a parallel three group longitudinal design. Subjects were randomly assigned either fat free milk or fat free soy protein that was isoenergetic, isonitrogenous, and macronutrient ratio matched to milk, or a carbohydrate only beverage for the control group. The beverages were consumed immediately and then again one hour after finishing the workout with the aim of promoting a full anabolic response (Miller, Tipton, Chinkes, Wolf & Wolfe, 2003). All beverages were flavored with vanilla so they would taste similar and served in opaque containers to prevent any comparisons among the subjects. The training exercises consisted of three groups: pushing exercises (military press, bench press, seated chest fly, and seated triceps extension), pulling exercises (seated lateral pull down, seated wide grip row, seated reverse fly, seated biceps curl, and a series of abdominal exercises without weights), and leg exercises (incline leg press, 2-leg extension, 2-leg hamstring curl, and seated calf raise). At the completion of the study each subject performed 60 weightlifting sessions consisting of 20 pushing, pulling and leg resistance exercise workouts. The findings indicated that the chronic consumption of fluid skim milk immediately and one hour after resistance exercise caused greater gains in fat and bone free mass and type II muscle fiber area than the other beverages consumed. There was also a greater reduction in body fat mass and greater anabolic stimulus with the milk protein. The greater fat loss seen in the milk subjects is not fully understood but is thought to be related to dietary calcium intake or an endogenous property of the milk proteins themselves (Hartman et al., 2007).

Another study that investigated post resistance exercise protein supplementation was conducted by Rankin et al. (2004). The researchers compared low fat chocolate milk and a carbohydrate electrolyte drink immediately following each workout during a ten week period. The participants were 21 untrained male subjects that had not been involved in either training or nutritional supplementation. The study did not find many differences between the two beverages. Muscular strength was increased by 44 ± 4% at the end of the ten week training period. These gains did not differ between the milk and carbohydrate electrolyte drink beverages. There were also no significant differences in body composition but the milk group demonstrated a non-significant increase in fat free soft tissue mass (p=0.13). The other variables that were tested and showed no significant differences were hormones and resting energy expenditure (Rankin et al., 2004).

Elliot et al. (2006) compared nonfat milk to whole milk consumption following an acute bout of resistance exercise. The study investigated the response of net muscle protein balance following resistance exercise and amino acids ingestion. The 24 healthy subjects were randomly assigned to either the fat free milk (237 g), whole milk (237 g), or isocaloric fat free milk group (393 g). The drink was administered after following ten sets of eight repetitions of knee extension exercise. The net balance of the amino acids phenylalanine and threonine changed from negative to positive following ingestion of all three milk drinks. The change in net muscle protein balance changing from negative to positive indicates that muscle anabolism is taking place as a result of the milk consumption (Elliot, Cree, Sanford, Wolfe & Tipton, 2006). The authors possess previous data that demonstrated that there was no change in net muscle protein balance following an identical bout of resistance exercise with placebo ingestion (Tipton et al., 2004). This study exhibits the need for testing over a chronic training period as opposed to an acute training period.

This same study also demonstrated the need for further research of whole milk versus fat free milk. The results found by Elliot et al. (2006) suggest that whole milk may have potential benefits when consumed post resistance training as opposed to fat free milk. This theory is supported by a greater uptake of threonine and phenylalanine in the whole milk group. The data suggests that some property of whole milk enhances the amount of these two amino acids that are utilized for muscle protein synthesis (Elliot, Cree, Sanford, Wolfe & Tipton, 2006). This increased utilization may be in part due to the extra energy that is contributed by the fat present in the whole milk. The findings also indicated that the total amino acid uptake was similar for the whole milk and isocaloric fat free milk group, but the whole milk group had greater utilization of amino acids for net muscle protein synthesis (Elliot, Cree, Sanford, Wolfe & Tipton, 2006).

Resistance Training and Female Athletes

There is limited softball research, but one recent study investigated correlations that are relevant to softball players in terms of strength and performance variables. Nimphius, Mcguigan & Newton (2010) recruited ten trained female softball players and tested for maximal lower body strength (1RM), peak force, peak velocity, and peak power using squat jumps, vertical jump height, and first base and second base sprint performance and change of direction performance. The testing took place pre, mid, and following a 20-week training period. These variables were tested to aid in determining whether a relationship exists between strength, power, and performance. Also, the research is limited in the area of strength, speed, and change of direction ability longitudinally in female athletes (Cronin ,Ogden, Lawton & Brughelli, 2007).

The study found significant relationships that explained at least half of the variance between variables that were found across all time points between body weight, speed, and change of direction measures ($r = 0.70$-0.93) (Nimphius, Mcguigan & Newton, 2010). The findings for vertical jump indicated that there were no significant relationships between vertical jump height and any measure of performance at any time. The primary findings of the study indicated that body weight and relative strength have strong to very strong correlations with speed and change of direction ability**.** It can therefore be concluded that the smaller sized athletes excel in the variables of speed, change of direction and relative strength. However, this should not be interpreted as smaller sized athletes will perform better in the game of softball. In addition, Nimphius, Mcguigan & Newton (2010) reported that first base sprint time assessed at pre, mid, and post testing had a very strong relationship to relative strength performance. This research indicates that performance in this set of trained female softball athletes displayed a strong relationship to relative strength of a higher magnitude than those that have been previously measured in male athletes (Baker, 2001). Also, the correlation between different measures of speed was more highly correlated in these female athletes than the correlations found in male athletes (Cronin & Hansen, 2005).

Another study using female softball athletes conducted by Jones, Matthews, Murray, Van Raalte & Jensen (2010) consisted of a 12-week off season strength and conditioning program using collegiate women who were members of the field hockey, softball, and soccer teams. The primary purpose of the study was to establish how physical and psychological measures were related in the three different sport groups of female athletes. It was hypothesized that performance testing improvements would be correlated with psychological measures.

Although the present study did not measure psychological variables, these Division-III female athletes were tested on basically three of the same variables, vertical jump, linear, and lateral speed. When all of the females from all sports were combined, there were improvements of 2.6% for vertical jump, 1% for linear speed, and less than 1% improvement for agility. In addition, all three groups assessed in the study experienced significant gains in upper and lower body strength as a result of participation in the strength and conditioning program. Upper body strength improvements ranged from 2.7% in field hockey players to 18% in soccer players. Lower body strength varied from 5.8% in field hockey players to 18% in soccer (Jones et al., 2010). Overall results suggest that female athlete's gains in upper and lower body strength may be attained over a 12-week period during a strength and conditioning program, however; improvements in power and speed are more difficult to achieve.

Kraemer et al. (2003) compared the physiological and performance adaptations between periodized and nonperiodized resistance training in women collegiate tennis athletes. Thirty females from three different universities, who were not currently involved in resistance training, participated in the study. Subjects were matched based on their ranking in the United States Tennis Association and randomly assigned to one of the three groups, nonlinear periodized resistance training, nonperiodized resistance training, or a control group not involved in resistance training but who performed all activities associated with tennis practice. Variables included body composition, anaerobic power, VO2max, speed, agility, maximal strength, and jump height.

The results showed no differences in the sprinting speed and agility times after resistance training in the both the periodized and nonperiodized training groups. There were also no observed differences among groups in the 10 and 20 meter sprint speeds or agility at any time point. The maximal countermovement jump height increased significantly during the resistance training in both groups but the percent increase in jump height after nine months was significantly greater after the periodized resistance training (about 50% vs 37%). This study demonstrated that heavier resistance training sessions rotated into the training sequence of different intensities may be essential for optimizing performance adaptations.

Summary

It has been established that a properly designed resistance exercise program is necessary to improve muscular strength and improve exercise performance (Kraemer et al., 2003). As for collegiate athletes and or people who are trying to increase muscle mass most quickly and efficiently, the literature suggests that post workout protein consumption is important (Biolo, Tipton, Klein & Wolfe, 1997; Borsheim, Tipton, Wolf & Wolfe, 2002; Tipton, Ferrando, Phillips, Doyle & Wolfe, 1999). Milk as an ergogenic aid has also increased in popularity and appears to be an effective post resistance exercise beverage that results in favorable acute alterations in protein metabolism (Roy, 2008). Milk ingestion also acutely increases muscle protein synthesis leading to an improved net protein balance (Roy, 2008; Elliot, Cree, Sanford, Wolfe & Tipton, 2006; Wilkinson et al., 2007). Studies have shown that that muscle fiber size and lean body mass were significantly increased in novice, male weightlifters (Hartman et al., 2007). Research is needed for other populations. Also, further research is needed to determine the ideal type of milk that should be consumed. It has been reported that those individuals that ingest whole milk may increase the utilization of available amino acids for protein synthesis as compared to those who ingested the fat free milk following an acute bout of resistance exercise. What is needed at this point is to conduct a chronic resistance training study in athletes who ingest fat free chocolate milk and whole chocolate milk and to determine if the training adaptations improve exercise performance.

Chapter Three

Methodology

Study Design

The study was conducted using a double blind protocol. The participants were randomized to either the fat free chocolate milk or the low fat chocolate milk group after being matched for bodyweight and lower body strength. Specifically, participants were matched for leg press and chest press strength and bodyweight, and within each pair, one subject was randomly assigned to one of two groups and the other subject to the other group.

Participants

Eighteen female collegiate athletes, 18 to 20 years of age, participated in the study. Initially, participants were randomly assigned to one of two groups: a fat free chocolate milk group (FF) or a low fat chocolate milk drink group (LF). All participants were cleared by a physician to compete in a collegiate level sport before the study began. In addition to having physician approval to engage in physical activity/collegiate athletics, a comprehensive health history form and assessment of resting heart rate and blood pressure was administered before each testing session.

Inclusion/Exclusion Criteria

All participants were required to be members of the St. Petersburg College softball team and had been cleared to participate by a physician.

Overview of Laboratory Visits

Participants were required to visit the St. Petersburg College Clearwater campus fitness center that is located on the St. Petersburg College Clearwater campus three times. Each laboratory visit required approximately 90 minutes.

Familiarization to the Exercise Tests

All familiarization, baseline and post-testing assessments were conducted at the St. Petersburg College Clearwater campus fitness center. Each participant was familiarized to each of the three exercise tests prior to baseline testing. This occurred approximately four weeks prior to baseline testing and was done to offset any learning curve that may be gained from performing the tests. The three exercise tests that were performed during the familiarization session (and the pre-and post testing sessions) were:

- Vertical Jump
- 20-yard sprint test
- Agility t-test

For a description of how these tests will be performed, refer to the following section titled "Baseline and Post-Testing Sessions".

Baseline and Post Testing Sessions

Baseline testing and the post-testing sessions were separated by eight weeks and conducted in the morning after an overnight fast. All pre-exercise and exercise tests were done in accordance with the American College of Sports Medicine and National Strength and Conditioning Association guidelines. Both of these testing sessions were identical and consisted of the following tests in the following order:

Pre-Exercise Testing Assessments:

- Resting heart rate assessment
- Resting blood pressure assessment
- Body weight assessment
- Body composition assessment

Exercise Testing Assessments

- Vertical Jump Test
- 20-yard sprinting test
- Agility t-test

Resting heart rate. Heart rate was conducted by a member of the research team and was accomplished by palpating the pulse for a 60-second period.

Resting blood pressure. Blood pressure was assessed by a member of the research team and was accomplished by using a standard sphygmomanometer and stethoscope.

Bodyweight assessment. The participant's body mass was obtained using the Detecto scale model 090.

Body composition assessment. Body composition was assessed by a seven site skinfold measurement using the Lange® caliper. The seven anatomical sites that were measured include the chest, midaxillary (about four inches below the armpit), triceps, subscapular (below the shoulder blade) abdomen, suprailiac (above the hip bone), and thigh. To conduct a skinfold assessment, the research assistant pinched the skin (while grasping the subcutaneous fat) and then measured the thickness of this fold using a

Lange® caliper. Measurements were made in millimeters. The principle behind this technique is that the amount of subcutaneous fat is proportional to the total amount of body fat. The American College of Sports Medicine female seven site formula was used to predict body composition.

Vertical jump test. The vertical jump utilized a commercial device (Vertical Challenger®) to determine how high each participant jumps vertically from the ground. Without a preparatory or stutter step, the participant performed a countermovement by quickly flexing the knees and hips, moving the trunk forward and downward, and swinging the arms backward. During the jump, the dominant arm reaches upward while the non-dominant arm moves downward relative to the body. At the highest point in the jump, the athlete taps the highest possible vane with the fingers of the dominant hand. The best of three trials was recorded to the nearest 0.5 inches.

The 20-yard sprint test. Speed was assessed by completing two 20 yard sprints timed with a stopwatch. The distance of 20 yards was chosen since it is the standard distance from home to first base in the sport of softball. Each subject was given a one minute passive rest in between bouts. The best time of the two sprint tests was used for analysis.

Agility t-test. Agility is the ability to start, stop, and change the direction of the body or body parts rapidly and in a controlled manner. The t-test is one of the most valid and reliable tests used to assess agility. To conduct a t-test, four cones were placed in a t-formation. On an auditory signal, the athlete sprinted from cone 1 to cone 2 and touched the base of the cone with the right hand. Then, while facing forward and not crossing the feet, the athlete shuffled to the left five yards and touches the base of cone 3 with the left hand. The athlete then shuffled to the right ten yards and touches the base of the cone 4 with the right hand. The athlete then shuffled to the left five yards and touched the base of cone 2 with the left hand, and then ran backward past cone 1. This test was timed with a stopwatch.

Supplementation Protocol

During the eight week intervention period, participants were assigned to ingest either chocolate milk containing low fat or fat free chocolate milk. The milk beverages were iso-nitrogenous (meaning that they contain the same amount of protein). The main difference between the two beverages is that one of them contained nine grams of fat per serving and the other contained no fat per serving. Upon resistance training completion, participants immediately consumed either a 16 oz Nesquik Chocolate Low Fat Milk drink containing 190 calories, 29 grams of carbohydrates, and 8 grams of protein (LF group), while the other group consumed a 16 oz Nesquick Chocolate Fat Free Milk drink containing 150 calories, 29 grams of carbohydrates, and 8 grams of protein (FF group). The consumption of the milk was supervised by the assistant coach of the St. Petersburg Softball team.

Resistance Training Protocol

The participants engaged in resistance training two to three times a week over an eight week period resulting in 21 total workouts. Immediately after each resistance exercise bout, each participant ingested their milk beverage (see "supplementation protocol" above). Resistance training sessions were conducted at the St. Petersburg College wellness center in Clearwater, FL. Prior to all resistance training sessions, participants performed a light jog, stretching, and agility drills. The resistance training program consisted of three workouts that are performed in a circuit fashion. Appendix 1 demonstrates the three circuit resistance training workouts that were conducted over the eight week study. There was approximately one minute of rest between each exercise. All aspects of the resistance training protocol were documented.

Instrumentation/Equipment

This study utilized five primary pieces of equipment: a vertical jump apparatus, a stopwatch, a blood pressure monitor, Lange caliper, and a scale.

Vertical jump apparatus = a device used to measure vertical jump (how high an individual can jump off of the ground). The vertical jump tester that was used in this study was the Vertical Challenger (Dallas, TX).

Stopwatch = a device used to measure how fast one can run for 20 yards and agility t-test. The stopwatch that was used in this study was the Accusplit 601 X 3V.

Blood pressure meter = Data was collected using a standard sphygmomanometer and stethoscope.

The Lange Skinfold Caliper = provides accurate measurement of subcutaneous tissue. The pivoted tips adjust for parallel measurement of skinfolds. The scale provides an accurate reading.

Scale = The participant's body mass was obtained using the Detecto scale model 090.

Each of these pieces of equipment are routinely used for research and fitness applications and do not involve unforeseen risks to participants.

Research Design and Data Analysis

Each participant was tested on each dependent variable two times (at the beginning of the study and after the eight week training period). The null hypotheses were tested via an independent samples t-test and the criterion for significance for all tests was set at $p < 0.05$.

Chapter Four

Results

Eighteen collegiate softball athletes participated in the study. Descriptive statistics for age, height, and weight are represented in Table 1.

Table 1: Characteristics of Study Participants (N=18)

Variable	**Mean**	**Standard Deviation**
Age (yrs)	18.5	0.71
Height (total; in)	65.7	1.8
Weight (total; lb)	156.2	21.6

The macronutrient intakes for every participant were also assessed at baseline and post test. This was accomplished through individualized diet logs at baseline and post testing. There were no significant differences between the two groups in relation to the macronutrient intakes. At baseline, there was no significant difference (p = 0.331) between groups for total caloric intake. Fat Free group = 2,080 calories, 2% group = 2,403 calories. At baseline, there was no significant difference (p = 0.520) between groups for total carbohydrate intake. Fat Free group = 236 grams, 2% group = 272 grams. At baseline, there was no significant difference (p = 0.378) between groups for total protein intake. Fat Free group = 97 grams, 2% group = 112 grams. At baseline, there was no significant difference (p = 0.341) between groups for total fat intake. Fat Free group = 84 grams, 2% group = 99 grams.

Table 2: Characteristics of Macronutrient Intake at Baseline Testing.

Macronutrients	Fat free group (calories)	Low fat group (calories)	P value
Total caloric intake	2,080	2,403	0.331
Total carbohydrate intake	236	272	0.520
Total protein intake	97	112	0.378
Total fat intake	84	99	0.341

At post-test, there was no significant difference (p = 0.594) between groups for total caloric intake. Fat Free group = 2,157 calories, 2% group = 2,328 calories. At post-test, there was no significant difference (p = 0.649) between groups for total carbohydrate intake. Fat Free group = 246 grams, 2% group = 263 grams. At post-test, there was no significant difference (p = 0.839) between groups for total protein intake. Fat Free group = 85 grams, 2% group = 87 grams. At post-test, there was no significant difference (p = 0.566) between groups for total fat intake. Fat Free group = 94 grams, 2% group = 106 grams.

Table 3: Characteristics of Macronutrient Intake at Post Testing.

Macronutrients	Fat free group (calories)	Low fat group (calories)	P value
Total caloric intake	2,157	2,328	0.594
Total carbohydrate intake	246	263	0.649
Total protein intake	85	87	0.839
Total fat intake	94	106	0.566

To test the null hypotheses, independent samples t-test were conducted to determine if there were significant differences in 20 yard sprint, vertical jump, and agility t-tests between the two groups. There were no differences between any of the variables assessed at baseline testing.

20 Yard Sprint

Ho_1 stated there will be no difference between the fat free chocolate milk group and the low fat chocolate milk group in the 20 yard sprint time. No statistically significant differences were found in 20 yard sprint times between the two groups (FF = 2.95 $\pm$ .20, LF = 2.94 $\pm$ .110, p = 0.914). Therefore, based on the non-significant results, we fail to reject the null hypothesis (Ho_1). Refer to table 4.

Vertical Jump

Ho_2 stated there will be no difference between the fat free chocolate milk group and the low fat chocolate milk group in the vertical jump performance. No statistically significant differences were found in the vertical jump heights between the two groups (FF = 15.62 $\pm$ 2.19, LF = 15.00 $\pm$ 1.51, p = 0 .519). Therefore, based on the non-significant results, we fail to reject the null hypothesis (Ho_2). Refer to table 4.

Agility T-Test

Ho_3 stated there will be no difference between the fat free chocolate milk group and the low-fat chocolate milk group in the agility t-test. No statistically significant differences were found in the agility t-test between the two groups (FF = 12.08 ± .830, LF = 11.98 ± .836, p = 0.818). Therefore, based on the non-significant results, we fail to reject the null hypothesis (Ho_3). Refer to table 4.

Table 4: Test Comparisons for Dependent Variables at Post-Testing

Variable	Fat free (mean ± SD)	Low fat (mean ± SD)	P value	Effect size
Vertical jump	15.62 ± 2.19	15.00 ± 1.51	0.519	0.16
20 yard sprint	2.95 ± 0.20	2.94 ± 0.11	0.914	0.06
Agility t-test	12.08 ± 0.83	11.98 ± 0.84	0.818	0.11

Note. Data were analyzed using Independent Sample t-Tests

With all participants combined there were no significant changes from baseline to post testing vertical jump, 20 yard sprint, and agility t-test. Refer to table 5.

Table 5: Test Comparisons for Dependent Variables at Baseline vs. Post testing

Variable	Baseline (mean ± SD)	Post Test (mean ± SD)	P value	Effect size
Vertical Jump	14.62 ± 1.85	15.31 ± 1.85	0.60	0.37
20 yard sprint	3.127 ± 0.183	2.94 ± 0.154	0.001	1.1
Agility t-test	12.24 ± 0 .835	12.03 ± .807	0.073	0.255

Note. Data were analyzed using Paired Sample t-Tests

Chapter Five

Discussion

The major, statistical, finding of this study is that the consumption of commercially available fat free chocolate milk versus low fat chocolate milk drink does not produce improvements in exercise performance in conjunction with an eight week periodized, resistance training program in collegiate softball players. The difference of 10 grams of fat (two servings per container) did not alter any of the performance variables (20 yard sprint, vertical jump or agility t-test).

The review of literature found that Wilkinson et al. (2007) and Hartman et al. (2007) demonstrated that milk was superior in comparison to the listed beverage alternatives. When comparing the different types of milk Elliot et al. (2006) found that whole milk may have potential benefits when consumed post resistance training as opposed to the isonitrogenous fat free milk. This theory is supported by a greater uptake of threonine and phenylalanine in the whole milk group. The data suggests that some property of whole milk enhances the amount of these two amino acids that are utilized for muscle protein synthesis (Elliot, Cree, Sanford, Wolfe & Tipton, 2006). This increased utilization may be in part due to the extra energy (i.e., additional fat in the whole milk). Although the current study did not measure amino acid uptake, the data was collected for eight weeks instead of an acute resistance exercise bout. The present study did not examine whole milk versus fat free but low fat versus fat free milk instead. The studies findings did not result in performance gains in the low fat milk group which contained the extra calories. A possible weakness could be that the low fat and nonfat milk were too similar in that the protein and carbohydrates were identical and the calories only differed by 40. However, it was thought that whole milk was not an appealing option due to the heaviness of the beverage and high caloric content for people who are looking for strength and performance gains and especially in the female population. This was also relevant due to the fact that many resistance training sessions were followed by a two to three hour softball practice. A major strength of the study was that all milk consumption was monitored by the St. Petersburg Colleges assistant coach. All participants were required to stay until the entire 16oz bottle was consumed.

There is limited research on softball athletes, but a previously mentioned study investigated correlations that are relevant to softball players in terms of strength and performance variables. Nimphius, Mcguigan & Newton (2010) recruited ten trained female softball players and tested peak force, peak velocity, and peak power using vertical jump height and first base and second base sprint performance and change of direction performance. The variables that were tested were very similar to those in the current study with the aim of determining whether a relationship exists between strength, power, and performance. Nimphius, Mcguigan & Newton (2010) reported that first base sprint time assessed at pre, mid, and post testing had a very strong relationship to relative strength performance. These findings indicate once again how important strength gains are for performance outcomes. In the present study, with both milk groups combined, there was an improvement of 4.7% for vertical jump, 6% for linear speed, and 1.7% for agility. A possible explanation for the differences in improvements between the two studies was the inclusion of a milk beverage in the present study.

Another study conducted by Jones, Matthews, Murray, Van Raalte & Jensen (2010) consisted of a 12-week off season strength and conditioning program using collegiate women who were members of the field hockey, softball, and soccer teams. All three groups assessed in the study experienced significant gains in upper and lower body strength as a result of participation in the strength and conditioning program. Overall results suggest that female athlete's gains in upper and lower body strength may be attained over a 12-week period during a strength and conditioning program, however; improvements in power and speed are more difficult to achieve. These findings coincide with those seen in the present study. A possible limitation of the present study is the eight week resistance training session. Due to dates that the athletes commenced for the start of the school year, the studies training period only allowed for the eight week protocol. However, a possible strength of the current study was the four week resistance training and conditioning period that took place before the baseline testing. During these four weeks, the freshman athletes were taught how to properly lift and do every exercise that took place during the study. The four weeks also allowed for every player to adapt to the resistance training and conditioning. This aids in eliminating the potential soreness at the beginning of the study which could result in lower intensities from the participants. In comparison to the studies in this area, familiarization periods are common but not a period of resistance training and conditioning.

Lastly, future research may want to focus on a longer training session with larger numbers of participants. A control group would also be a helpful addition so that all results could be compared to the independent variable. Using the athletic and trained population may also help to obtain realistic results.

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Appendices

Appendix 1: Circuit Sheet

Player Name:________________________________

	Week 1		Week 2		Week 3		Week 4	
Circuit 1- Monday	Weight	2 x 10	Weight	2 x 10	Weight	2 x 10	Weight	2 x 10
Chest: Nautilus Vertical Press		/		/		/		/
Biceps: Hammer Curls		/		/		/		/
Legs: Leg Curl		/		/		/		/
Back: Lat Pulldown		/		/		/		/
Triceps: Tricep Pushdown		/		/		/		/
Legs: Walking Lunge w/DB		/		/		/		/
Shoulders: Seated DB Press		/		/		/		/
Circuit 2- Wednesday	Weight	2 x 10	Weight	2 x 10	Weight	2 x 10	Weight	2 x 10
Chest: DB Press		/		/		/		/
Biceps: 21's		/		/		/		/
Legs: Leg Press		/		/		/		/
Back: Nautilus Row		/		/		/		/
Triceps: DB overhead extension		/		/		/		/
Legs: Step-ups w/DB		/		/		/		/
Shoulders: Machine Press		/		/		/		/
Circuit 3- Friday	Weight	2 x 10	Weight	2 x 10	Weight	2 x 10	Weight	2 x 10
Chest: Nautilus Flat Bench		/		/		/		/
Biceps: DB Curls		/		/		/		/
Legs: Leg Extension		/		/		/		/
Back: Reverse Fly		/		/		/		/
Triceps: Bench Dips		/		/		/		/
Legs: Smith Squats		/		/		/		/
Shoulders: Lateral Raise		/		/		/		/