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Effects of eccentric weight training and a whey beverage on muscular hypertrophy and strength in trained males

Meagan Mary O’Connor

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ABSTRACT

EFFECTS OF ECCENTRIC WEIGHT TRAINING AND A WHEY BEVERAGE ON MUSCULAR HYPERTROPHY AND STRENGTH IN TRAINED MALES

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Family, Consumer and Nutrition Sciences
Northern Illinois University, 2015
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Background: Consumption of high quality protein and carbohydrates post resistance exercise has been shown to increase muscle mass while decreasing muscular damage. Eccentric only exercises have been shown to increase muscle hypertrophy and strength.

Methods: Twenty-three resistance-trained males age 18-30 enrolled in this study and were randomly assigned to either a 29 g whey protein isolate or 132.5 g whey and carbohydrate beverage following an 8-week eccentric only resistance weight lifting protocol. 19 participants tested one-rep maximum tests for the bench press and leg press along with anthropometric measurements prior to, halfway through, and following completion of the study.

Results: Split-plot repeated measures ANOVA revealed that both groups experienced significant increases in muscle strength, muscular hypertrophy, and lean body mass.

Conclusion: There was a statistically significant (p<0.05) increase in muscle strength, hypertrophy, and lean body mass following the eight-week eccentric resistance training study. However, the increases were due to the lifting protocol and not a specific supplement consumed.
EFFECTS OF ECCENTRIC WEIGHT TRAINING AND A WHEY BEVERAGE ON MUSCULAR HYPERTROPHY AND STRENGTH IN TRAINED MALES

BY

MEAGAN MARY O’CONNOR
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A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE MASTER OF SCIENCE

SCHOOL OF FAMILY, CONSUMER AND NUTRITION SCIENCES

Thesis Director:
Judith Lukaszuk
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DEDICATION

This is dedicated to my loved ones, especially Mom and Dad, for their constant support and belief that I can achieve whatever I put my mind to.
# TABLE OF CONTENTS

| LIST OF TABLES | vii |
| LIST OF APPENDICES | viii |

## Chapter

1. INTRODUCTION
   - Justification ........................................... 1
   - Hypotheses ............................................. 4

2. REVIEW OF LITERATURE
   - Carbohydrate/Protein Drinks Effect on Muscles with Exercise .......... 6
   - Weight Training and Strength .................................. 9
   - Muscle Hypertrophy .......................................... 13

3. METHODOLOGY
   - Subjects ................................................. 17
   - Eccentric Weightlifting Routine ................................ 19
   - Muscle Hypertrophy Assessment .................................. 19
Strength Assessment. .............................................................. 20
Diet Analysis................................................................. 22
Statistical Analysis. .......................................................... 23

4. RESULTS ........................................................................... 24
Subjects................................................................................. 24
Muscular Strength............................................................... 25
Bench Press ............................................................................ 25
Leg Press ................................................................................. 26
Bench Press Relative to Body Weight .................................... 27
Leg Press Relative to Body Weight ....................................... 27
Elbow Flexion ....................................................................... 29
Elbow Extension .................................................................... 30
Knee Flexion ......................................................................... 30
Knee Extension ....................................................................... 30
Muscular Hypertrophy .......................................................... 31
Chest ....................................................................................... 31
Upper Arm .............................................................................. 31
Waist ....................................................................................... 33
Hip .......................................................................................... 33
Thigh ....................................................................................... 33
Body Composition ............................................................... 34
Body Weight ........................................................................... 34
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean Body Mass</td>
<td>34</td>
</tr>
<tr>
<td>Body Fat Percentage</td>
<td>36</td>
</tr>
<tr>
<td>Three-Day Food Log</td>
<td>36</td>
</tr>
<tr>
<td>5. DISCUSSION</td>
<td>38</td>
</tr>
<tr>
<td>Muscular Strength</td>
<td>39</td>
</tr>
<tr>
<td>Muscular Hypertrophy</td>
<td>41</td>
</tr>
<tr>
<td>Body Composition</td>
<td>42</td>
</tr>
<tr>
<td>3-Day Food Log</td>
<td>44</td>
</tr>
<tr>
<td>Conclusion</td>
<td>46</td>
</tr>
<tr>
<td>6. LIMITATIONS AND FUTURE RESEARCH</td>
<td>47</td>
</tr>
<tr>
<td>Limitations</td>
<td>47</td>
</tr>
<tr>
<td>Future Research</td>
<td>48</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>49</td>
</tr>
<tr>
<td>APPENDICES</td>
<td>53</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical Characteristics of Subjects</td>
<td>25</td>
</tr>
<tr>
<td>2. Strength Gains Following 8 Weeks of Eccentric Only Wt Training</td>
<td>26</td>
</tr>
<tr>
<td>3. Strength Relative to Weight</td>
<td>28</td>
</tr>
<tr>
<td>4. Elbow/Knee Flexion/Extension Strength Following 8 Weeks of Eccentric Only Wt Training</td>
<td>29</td>
</tr>
<tr>
<td>5. Muscle Hypertrophy</td>
<td>32</td>
</tr>
<tr>
<td>6. Body Composition</td>
<td>35</td>
</tr>
<tr>
<td>7. Three-Day Food Log Results</td>
<td>37</td>
</tr>
</tbody>
</table>
# List of Appendices

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Recruitment Flyer</td>
<td>54</td>
</tr>
<tr>
<td>B. Medical History Form</td>
<td>55</td>
</tr>
<tr>
<td>C. Informed Consent</td>
<td>60</td>
</tr>
<tr>
<td>D. Complete IRB Application</td>
<td>63</td>
</tr>
<tr>
<td>E. Eccentric Weight Lifting Protocol</td>
<td>84</td>
</tr>
<tr>
<td>F. Soreness Scale</td>
<td>93</td>
</tr>
<tr>
<td>G. Anthropometrics Data Sheet</td>
<td>94</td>
</tr>
<tr>
<td>H. Three-Day Food Log</td>
<td>98</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

Justification

Sedentary lifestyles are strongly linked to increased health risks such as obesity, cardiovascular disease, a reduction in bone mineral density, and type 2 diabetes (1). At present, only 49.1% of American adults meet the minimal physical activity standards set forth by both the American College of Sports Medicine and the American Heart Association (2).

Physical activity or exercise guidelines recommend a minimum of 30 minutes of moderate-intensity activities five days a week for aerobic activities (2), such as running or brisk walking, both of which focus on cardiovascular health. For vigorous-intensity aerobic physical activity, the recommendation is a minimum of 20 minutes three days per week (2). However, another important component of exercise essential for balance, bone health, and muscle strength (3), is anaerobic exercise such as resistance training. To promote and maintain good health, adults benefit from activities that maintain or increase muscular strength and endurance for a minimum of two days each week (2). It is recommended that two to three sets of 8–10 repetitions be performed on two or more nonconsecutive days each week using the major muscle groups (2), which include legs, hips, back, abdomen, chest, shoulders, and arms. To maximize strength development, a resistance (weight) should be used that allows multiple sets of 8–12 repetitions of
each exercise resulting in volitional fatigue (2). Muscle-strengthening activities include a progressive weight-training program, weight bearing calisthenics, or any similar resistance exercises that use the major muscle groups (2). Research has concluded that individuals lifting weights gain on average one pound per month of lean muscle mass during the first several months of training (3).

Traditional resistance training programs are designed to increase muscle strength, power, and size. Two distinct phases of movement in muscles are concentric (contracting) and eccentric (lengthening) (4). Most programs focus on overloading the muscle during the concentric phase. During everyday activities, concentric actions start movements whereas, eccentric actions slow activity down (4). Eccentric actions have been referred to as “negatives” or “eccentrics” (4). Traditional resistance training programs ranging from two to six months are designed to overload muscle and increase muscular strength, power and hypertrophy (4). Eccentric strength is especially important for physical functions such as walking downstairs or lowering objects to the ground (4). Because a person can lower more weight than they can lift, programs focusing on eccentric movements are being designed to hasten increased muscle strength through resistance training (4). In addition to experimenting with various weight training methods, several studies have examined the effects of protein and carbohydrate consumption on muscle building and related resistance training outcomes (5).

Recent research has shown that carbohydrates, whey protein and amino acids, such as glutamine, may aid in recovery of muscle stores (6,7). An adequate source of carbohydrates can be used by muscle to synthesize glycogen, which is the stored source of glucose in skeletal muscles. Insulin sensitivity as well as muscle membrane permeability is increased post-exercise,
therefore leading to an increased rate of muscle glycogen synthesis (8). Insulin favors glycogenesis through the activation of a phosphatase that dephosphorylates glycogen synthase (9). Rich sources of proteins, such as whey, may also aid in muscle store recovery through both glycogen repletion and muscle protein synthesis in response to increased insulin sensitivity (8). Insulin increases muscle amino acid uptake as well as protein synthesis while reducing protein degradation, and is key to limiting muscle damage as well as stimulating protein accretion (8). Whey protein is digested and absorbed more quickly than any other amino acid on the market, getting essential amino acids circulating in the bloodstream (3). Activation of protein synthesis by amino acids is most responsive immediately following exercise (8). The optimum timing for ingestion to promote muscle recovery and adaptation via glycogen recovery and protein synthesis is after exercise because the abilities of insulin to stimulate glucose uptake and suppress protein breakdown in skeletal muscle are increased (10).

In the scientific literature, there are no known studies that directly compare eccentric weight training paired with a carbohydrate/protein supplement. Nor are there studies that directly examine the effect of eccentric weight training on muscle hypertrophy and strength. The purpose of this study was designed to determine if an eccentric only weight lifting regimen with a whey and carbohydrate supplement postexercise is superior to whey protein isolate supplement post the eccentric protocol to promote strength, muscle hypertrophy, and change in body composition. The results of this study will help to provide information about whether the whey protein isolate (WPI) or the carbohydrate and whey (WC) beverage has a greater effect on muscle size and strength gains. The results also provide information on the most advantageous weight lifting regimen to employ to gain muscle strength and hypertrophy.
Hypotheses

1. There will be a difference in muscle hypertrophy after consuming a WC supplement versus a WPI supplement when following an eccentric weight lifting regimen.

   Independent Variable: Eccentric weight lifting regimen
   Independent Variable: Whey protein isolate supplement, Carbohydrate/Whey Supplement
   Dependent Variable: Circumference measurements at the upper arm, chest, waist, hips, thighs
   Statistics used: Split-plot repeated measures analysis of variance

2. There will be a difference in muscular strength after consuming a WC supplement versus a WPI supplement when following an eccentric weight lifting regimen.

   Independent Variable: Eccentric weight lifting regimen
   Independent Variable: Whey protein isolate supplement, Carbohydrate/Whey Supplement
   Dependent Variable: Max bench press (1RM), Max leg press (1RM)
   Statistics used: Split-plot repeated measures analysis of variance
3. There will be a difference in body composition after consuming a WC supplement versus a WPI supplement when following an eccentric weight lifting regimen.

Independent Variable: Eccentric weight lifting regimen

Independent Variable: Whey protein isolate supplement, Carbohydrate/Whey Supplement

Dependent Variable: Lean body mass in kilograms, fat mass percentage

Statistics used: Split-plot repeated measures analysis of variance
CHAPTER 2

LITERATURE REVIEW

Carbohydrate/Protein Drinks Effect on Muscles with Exercise

Performance during exercise is influenced by the amount of glycogen and protein stored in both skeletal muscle and liver at the onset of the exercise (8). As glycogen stores are depleted endurance performance stops or slows significantly (10). The re-synthesis of glycogen between training sessions occurs most rapidly if carbohydrates are consumed within 30 minutes to one hour after exercise (10). To optimize muscle recovery one must replete glycogen stores and activate protein synthesis to attenuate protein breakdown (8).

Protein degradation increases with resistance exercise leading to a negative protein balance (synthesis minus degradation) if not enough protein is consumed subsequently to offset loss (10). Leucine has been indicated as the sole stimulator of protein synthesis promoted through both insulin-dependent and insulin-independent mechanisms (6). While adding just protein or carbohydrate alone may aid in muscle recovery, it is more beneficial to mix the two macronutrients. By combining carbohydrate and protein, muscle protein breakdown is reduced due to an increase in insulin levels (8). Insulin is an anabolic hormone, which reduces protein degradation post-exercise (12). The addition of adequate protein to a post-exercise carbohydrate
supplement is vital for optimizing protein synthesis, creating positive protein balance, repairing muscle damage, and stimulating training adaptations (13). Protein is an essential macronutrient, and approximately 22% of muscle tissue is comprised of it, while water makes up the remaining 78% of muscle tissue (5). The adult Recommended Dietary Allowance (RDA) of protein each day is 0.8 grams per kilogram body weight.

It is recommended that protein intake be distributed throughout the day (e.g., breakfast, lunch, dinner, and post-exercise snack) rather than at a single protein-rich meal as the amount of protein that can be consumed at one time without exceeding the body’s ability to utilize it has not been established (5). The best time to ingest extra protein is either just before or just after a strength training session because doing so significantly enhances muscle development (12). Consuming protein at this time augments muscle glycogen replenishment as well as activates protein synthesis.

A study completed by Cribb and Hayes (11) had participants perform resistance training exercises, and consume a drink made with a blend of protein and carbohydrates twice each day on workout days only. Some took the supplement pre- and post-workout, while the others took it in the morning and evening (11). After 10 weeks of training, the study participants who took the protein/carbohydrate supplement pre- and post-workout gained significantly more lean weight than those who ingested the protein/carbohydrate supplement during the morning and evening (11). The pre- and post-workout supplement group also showed significantly greater increases in bench press strength and squat strength than the morning/evening supplement group. In addition, the pre- and post-workout supplement participants demonstrated significantly greater increases in fast twitch type IIa muscle fiber cross-sectional area, fast twitch type IIx muscle fiber cross-sectional area, and contractile protein content than the morning/evening supplement group.
Based on their findings, the authors concluded that supplement timing represents a simple, yet effective, strategy to enhance the positive physiological adaptations that are associated with resistance training (11).

Another study by Westcott (5) stated that the combination of carbohydrate with protein or amino acids in a supplement may contribute to a more effective protein uptake and enhanced synthesis rate of muscle protein (5). Westcott (5) concluded that although carbohydrates play a limited role in protein synthesis, they are vital to replenish glycogen stores diminished from prolonged or high-intensity exercise (5). Some researchers have suggested that taking appropriate protein may optimize resistance exercises and carbohydrate supplements post exercise (11). Based on Cribb and Hayes’ study, as well as the Ivy’s interpretation of previous research, a supplement that provides 0.5 to 0.6 g of protein plus 1.0 to 1.2 g of carbohydrate per kilogram of bodyweight is recommended (13). Providing carbohydrate and protein supplements both immediately and two hours post exercise can increase the rate and amount of muscle glycogen replenishment, reduce muscle damage, and increase the rate of muscle protein synthesis to a greater degree than providing carbohydrate or protein alone (13). A combination of carbohydrate and protein in supplementation leads to greater gains in muscle mass and strength (13). Proteins such as whey and casein block protein breakdown, preserving protein and muscle that in return, aids in the recovery process (13).

Protein consumption may enhance rates of muscle protein synthesis, as well as decrease muscle protein breakdown (10). Whey protein accounts for about 20% of the total protein found in milk (10). Whey has been extensively studied and proven to be one of the most bioavailable sources of protein that a person can consume (10). Whey protein in particular is highly enriched in leucine, which appears to translate into a greater ability of this protein fraction to stimulate
muscle growth, at least compared with soy (10). Whey protein supplementation consumed after a workout hastens the muscle recovery process and stimulates protein synthesis (10,14,15). Whey protein contains a large proportion of branched chain amino acids which have an integral role on muscle metabolism and protein synthesis (16). Protein may act as more than a substrate to supply the building blocks for protein synthesis and may be an important trigger to affect phenotypic changes generated by exercise. Leucine in particular is of importance since it acts as a stimulatory signal for muscle protein synthesis (12). Specific amino acids such as leucine, other branched chain amino acids, or glutamine are ideal for muscle building and recovery (10). Leucine increases levels of insulin, whereas glutamine (the most abundant amino acid in the body) increases post-exercise storage of glycogen (10).

Weight Training and Strength

Weight training, also known as weight lifting, is a system of conditioning involving lifting weights especially for strength and endurance (17). Athletes use it to improve their performance, non-athletes use it for general conditioning or bodybuilding, and those recovering from an injury may use it as part of an overall rehabilitation program (17). Another term for weight training, weight-bearing exercise, has been proven to be beneficial for a healthy life (18). It may lower risk factors of various diseases such as osteoporosis, cardiovascular disease (CVD), and type 2 diabetes (18). It also has been found to improve muscle strength, balance, coordination and mobility, all of which may help reduce falls and fall-induced bone fractures (18). According to Vainionpa, Korpelainan, Knip et al. (19), the effect of impact exercise on physical performance and cardiovascular risk factors, the exercise regimen initially designed to
load weight-bearing bones demonstrated positive effects on extra-skeletal risk factors of osteoporotic fractures and physical performance and also on some of the main risk factors of CVD (19). The most distinct improvements are found in the explosive power properties and muscle mass of the lower limbs and oxygen uptake (19). High-impact exercise also has been found to improve muscular performance, dynamic balance, and oxygen uptake in healthy individuals (19).

There are three distinct phases of movement on muscles, isometric (not moving), concentric (contracting) and eccentric (lengthening). Eccentric training focuses on slowing down the exercise process in order to challenge the muscles, then leading to stronger muscles, faster muscle repair and an increase in metabolic rate (20). Eccentric movements protect joints of bones from damage as muscles are contracted (20). Concentric training requires joints to change position and shortens the length of the affected muscles (20). Eccentric contractions are characterized by greater force at a given angular velocity than concentric contractions, and a higher occurrence of delayed onset muscle soreness after exercise (21). In the early stages of rehabilitation, if joint motion is possible but the muscles surrounding the joint are weak, eccentric exercise may be easier than concentric exercise (21). This can be exemplified by controlled lowering of a limb with gravity rather than a shortening contraction against gravity. Fewer motor units must fire to control the same load eccentrically as concentrically, so less effort is required (21).

Increases in muscular strength are induced by the performance of low-repetition high-force muscle actions (20). Although heavy-resistance training may produce muscle hypertrophy, the increased strength observed subsequent to short-term programs is mainly due to neural adaptations (20), which is the ability of the nervous system to activate the muscles. It is generally
accepted that neural factors play an important role in muscle strength gains. An increase in muscular strength without noticeable hypertrophy is the first line of evidence for neural involvement in acquisition of muscular strength. The use of surface electromyographic (SEMG) techniques reveal that strength gains in the early phase of a training regimen are associated with an increase in the amplitude of SEMG activity (22). SEMG magnitude is lower for eccentric contractions than for concentric contractions, however, resistive training can reverse these trends (21). One way to test whether or not resistance training is working is by assessing a one repetition maximum.

One repetition maximum (1RM) training is the maximum amount of weight an individual is able to lift in a single repetition of a given exercise (23). 1RM is used as an upper limit, which determines the desired amount of weight an individual should use in weight training. For safe and effective resistance training, the American College of Sports Medicine (ASCM) recommends that the average, healthy person perform at least one set of eight to twelve repetitions of a weight that feels challenging by the last couple of repetitions (23). This method of training corresponds to a resistance that is approximately 60–80% of a person’s 1RM and is a sound guideline that will yield a good balance of strength and muscular conditioning.

Maximal voluntary force is greater during eccentric than concentric muscle actions (20). If high force production in itself is a decisive stimulus for strength increases, then it appears that training optimizing the eccentric load is more effective than training consisting of concentric muscle actions only (20). When eccentric and concentric muscle actions using free weights were compared, greater strength increases were demonstrated subsequent to maximum training employing voluntary eccentric muscle actions, or combined overload eccentric and concentric muscle actions, than training using concentric muscle actions only (20). However, eccentric
training regimens not necessarily providing optimal load have produced strength gains comparable to those of concentric training (20). It has been suggested that heavy resistance training, emphasizing high-load and low repetition (4-6 repetition maximum) exercises will produce neural adaptations, whereas, moderate loads and repetitions (8-10 repetition maximum) are associated with muscular hypertrophy (21).

A study by Godard et al. (24) that increased the load during the eccentric action while still permitting 8-10 repetitions, produced greater muscular adaptation than typical training may permit (21). High loads during the eccentric muscle action are associated with greater muscle damage and possibly, subsequent hypertrophy (24). Motor unit recruitment during controlled eccentric actions has also been associated with preferential recruitment of fast twitch fibers, which have demonstrated a greater hypertrophic potential than slow twitch fibers (21). High eccentric loads may also reduce neural inhibition that would then lead to a greater generation of concentric force (22). A study by Bradenburg and Docherty (25) comparing dynamic constant external resistance (DCER) to dynamic accentuated external resistance (DAER) training on strength and neuromuscular adaptations, showed significant improvements in concentric strength for both DCER and DAER (25). The DAER training produced a greater development of elbow extensor strength than the DCER training (25). When comparing their study to the Godard et al. study, Bradenburg and Docherty (25) found that the increases in strength were greater in the Godard study (101-106%) than his study (9-24%). The Godard et al. study (24) also showed increases in muscular hypertrophy of the thigh, while there were no changes in muscular hypertrophy of the elbow during the Bradenburg/Docherty study (25). Bradenburg and Docherty believed these differences were due to the untrained status of the subjects in the Godard et al. study as opposed to the trained subjects in the Bradenburg/Docherty study (25). The vast gain in
strength during the Godard et al. study (24) may have been attributable to a learning effect from training with isokinetic muscle actions in addition to the neural adaptations normally associated with individuals unfamiliar with resistance training (24). Subsequently, the present study will recruit trained individuals to participate to further test whether training status has an effect on muscle strength and hypertrophy.

Muscle Hypertrophy

Muscle hypertrophy is a term for the growth and increase in muscle; the most common type of physical exercise augmenting muscular hypertrophy is weight lifting (26). Many recreational lifters who aspire to develop healthy physiques pursue muscle hypertrophy. Therefore, the maximization of muscle mass has far reaching implications to a variety of populations associated with sports and health. In untrained subjects, muscle hypertrophy is virtually nonexistent during the initial stages of resistance training, with the majority of strength gains resulting from neural adaptations (27). Within a couple weeks of training, however, hypertrophy begins to become the dominant factor, with the upper extremities shown to hypertrophy before the lower extremities (27). Genetic background, age, gender, and other factors have been shown to mediate the hypertrophic response to a training protocol, affecting both the rate and the total amount of gains in lean muscle mass (27). Further, it becomes progressively more difficult to increase lean muscle mass as one gains training experience, heightening the importance of a proper lifting routine (27).

Muscle hypertrophy can be considered distinct and separate from muscle hyperplasia, which results in an increase in the number of fibers within a muscle (27). During hypertrophy,
contractile elements, also known as microfilaments, enlarge and the extracellular matrix expands to support growth (27). There is controversy as to whether hypertrophy of existing muscle fibers determines the enlargement of muscles entirely (27). The role muscle fiber hypertrophy has in muscle enlargement is supported by a majority of human cross-sectional studies involving resistance-trained athletes (28). An increase in sarcomeres or myofibrils added in parallel is a result of traditional resistance training, which then leads to hypertrophy induced by exercise. After an overload stimulus in skeletal muscle, there is an increase in the size and amounts of contractile myofibrillar contractile proteins actin and myosin (27). The diameter of individual fibers is then increased in the cross-sectional area of the muscle (27). Although concentric and isometric contractions have been shown to produce a hypertrophic response, recent studies seem to show that eccentric actions have the greatest effect on muscle development (28).

“Lengthening” or eccentric exercises specifically have been associated with a more rapid rise in protein synthesis compared to “shortening” or concentric exercises (28). Isotonic and isokinetic training that does not include eccentric contractions result in less hypertrophy than those that include the eccentric contractions (28). Resistance studies using only concentric exercises have either failed to find fiber hypertrophy, or only found hypertrophy in type II (fast twitch) fibers (27). In another study, hypertrophy of type I (slow twitch) fibers occurred when training included both concentric and eccentric exercises (29).

As stated previously, muscle fibers are defined as either slow or fast twitch fibers. Fast twitch fibers can be further subdivided into type IIa and IIx (30). Slow twitch oxidative fibers are identified by a slow contraction time and a high resistance to fatigue (30). They have a small motor neuron as well as fiber diameter (30). Slow twitch muscle fibers contain a high amount of myoglobin, low glycogen content, an abundance of triglycerides, and a low supply of creatine
phosphate, which is generally used for quick movements (30). Most activities of daily living, as well as low intensity exercises aimed at muscular endurance, use slow twitch fibers. Some examples include walking, keeping posture, and aerobic activities such as running a 5 kilometer (or 3.1 mile) race.

Fast twitch fibers have a low resistance to fatigue yet have a fast contraction time (30). Fast twitch type IIa (fast twitch oxidative) are the transition between slow twitch and fast twitch IIx fibers (30). IIa muscle fibers are used for sustained power activities such as power lifts below maximum force or running 400 meters (or one-fourth of a mile) (30). They have a large motor neuron and fiber diameter, are high in creatine phosphate and glycogen, while containing an average amount of triglycerides (30). Fast twitch IIx fibers (fast twitch glycolytic) are extremely sensitive to fatigue, and are used for high-force, short anaerobic activities (30). These activities include sprinting, jumping, and shot putting. These IIx muscle fibers have a potential to produce more power than slow twitch fibers (30). Consistent with fast twitch IIa, IIx muscle fibers have a large motor and fiber diameter. They are high in creatine phosphate and glycogen, but are low in triglycerides (30).

Muscle-damaging eccentric resistance-type leg exercise was used for a blood oxidative-stress investigation with the intent of examining the relationship between eccentric exercise and muscle fiber type (31). The rise in plasma protein carbonyl concentration following low-intensity eccentric leg exercises was positively correlated with fast twitch muscle fiber (both IIa and IIx) (31). Plasma protein carbonyl concentration is utilized to indicate protein oxidization (the catabolism of protein) (32). The peak oxidative stress response after eccentric exercises was correlated with lean body mass as well as jump-test performance. These data demonstrate that
blood oxidative stress after low-intensity eccentric resistance exercise is related to the predominance of fast twitch muscle fiber, lean body mass, and anaerobic exercise performance (31).
CHAPTER 3

METHODOLOGY

Subjects

This study used a randomized control group repeated measures experimental design. Twenty-three healthy men aged 18-30 with more than one-year of weight lifting experience were eligible to participate in this study. Subjects were recruited using informational flyers (Appendix A) posted on the university campus and fitness centers within a 20-mile radius of campus. Exclusion criteria (Appendix B) included use of anabolic androgenic substances (AAS) within the past year and use of performance enhancing supplements within the last six weeks prior to the start of the study (anabolic agents, hormones and related substances, beta-2 antagonists, hormone antagonists and modulators, diuretics and other masking agents, stimulants, narcotics, cannabinoids, glucocorticosteroids, beta blockers). Subjects provided signed consent to participate (Appendix C) prior to enrollment in the study.

All study procedures were approved by Northern Illinois University Institution Review Board (Appendix D) prior to starting the study. This study used a controlled pre/post experimental design. Subjects participated in eccentric only lifting ($N=23$) and random assignment was used to assign the participants to receive either Dymatize Iso 100 (Dymatize
Enterprises, LLC, 2014, Bedford, TX) WPI beverage \((n=12)\) or Vitargo POST (Vitargo Global Sciences, LLC, 2014, Dana Point, CA) WC beverage \((n=11)\) immediately following weight training during this 8-week study. The two supplements were measured out to the nearest hundredth of a gram to match protein and leucine content. Each subject receiving the WPI supplement received 29.2 g, this was equivalent to 25 g of protein and 2.7 g leucine. Each subject receiving the WC supplement received 132.5 g, this was also equivalent to 25 g of protein and 2.7 g leucine, and contained 88 g of carbohydrate. The subjects mixed their supplement with 10-12 fluid ounces of water in a shaker bottle after each weight lifting session, and consumed it immediately after mixing, before leaving the training session.

Anthropometric data was recorded before, at the 4-week midpoint, and following the study in light exercise clothing and bare feet using a calibrated digital scale (InBody 520, Biospace Inc, Los Angeles, CA). Height was assessed using a wall AlignaBod (The Posture Company, Dallas TX). Weight, fat mass, percent fat and lean mass, as well as body mass index was assessed using InBody 520. Participants were instructed to come well hydrated and excrete urine before testing on the InBody 520, if not well hydrated then the individual had to redo the assessment the next day. Each participant was also instructed to remain standing for at least five minutes before the InBody 520 assessment, as body water tends to move to the lower extremities as the person stands after sitting for any period of time. The InBody 520 calculated body composition (lean body mass and percent body fat) as well as body mass index (BMI) using the standard equation (kilogram per meter squared).
Eccentric Weightlifting Routine

All subjects performed an identical eccentric only weightlifting protocol (Appendix E) with the assistance of a spotter for the concentric portion of the lifts. All resistance training was performed in one of the gyms located on the university campus. Weeks 1-4 required the participants to come in twice weekly for approximately a 1-1.5 hours. Weeks 5-8 required participants to exercise three nonconsecutive days of the week. Subjects attended the weight lifting sessions at the same time each day. Members of the research team lifted the concentric portion of each exercise for each of the participants, and the participants lowered the eccentric portion for a count of four. The amount of weight used for each exercise was based on a percentage (ranging from 100-125%, depending on the training week) of each individuals’ 1RM. Once 1RM was reassessed during the midpoint of the study, the weights were based off the new 1RM for each individual. Participants filled out 10 cm soreness scales indicating the level of soreness they were experiencing from their Monday training session on Wednesday before lifting that day (Appendix F). The soreness scale was a form of visual analogue scales (VAS), which is a psychometric response scale.

Muscle Hypertrophy Assessment

Muscle fiber hypertrophy was assessed by using a 60-inch cloth tape, this was measured by one trained research assistant at all the assessment points of the study. All muscle hypertrophy testing was performed in the Neuromuscular Lab on the university campus. For each participant,
the following body measurements were monitored: upper arm, chest, waist, hips, and thighs (Appendix G). For the upper arm measurements, the midpoint between the elbow joint and the glenohumeral joint was used. When assessing thigh measurements, the midpoint between the acetabulofemoral (hip) and tibiofemoral/patellofemoral (knee) joints was used. For the chest, the appropriate placement was level with the areolas. Abdominal circumference was measured with a cloth tape anteriorly halfway between the lowest portion of the ribcage and the iliac crest. Finally, the hips were measured two inches below the iliac crest of the hips. This is the protrusion of the hips in the frontal plane of the body. Body measurements were completed prior to the strength assessments at both the baseline, midpoint and following the study, they were measured to the nearest 1/16th of centimeter (cm). The measurements were pulled snuggly on the belly muscle but not too much so that it made an indentation on the skin.

Strength Assessment

Each participant had upper and lower body strength assessed using the CSMi’s Humac machine (Norm Testing and Rehabilitation System Computer Sports Medicine, Inc. Stoughton, MA) (Appendix G). The maximal strength assessments were performed on the Humac machine, which was calibrated according to CSMi’s user manual before each day of testing. The participants sat with the back angle of the chair set at ninety degrees during the isometric knee extension and flexion strength assessment of the non-dominant leg and isometric testing of the bicep and tricep muscles. For the isometric knee flexors and extensors, the participants were secured with adjustable belts across the chest, shoulders, and hips. The alignment of the lateral epicondyle of the knee to the axis of rotation was done visually along with the ankle cuff
placement superior to the lateral malleolus and checked by hand with a goniometer. The maximal isometric knee extension and flexion strength assessment was performed three times each at a forty five degree angle and held for five seconds to measure maximal force of the extensors and flexors. Average torque in Nm was measured. Participants were given fifteen seconds of rest between each trial, and allotted more time if needed. A warm-up set of one isometric contraction, at an angle of 45 degrees, was completed for five seconds before both the flexion and extension exercises. The same protocol for the arm extensors and flexors (bicep and tricep) muscles was examined for three five-second isometric contractions on the non-dominant arm. The work sets were done at speeds of 60 and 210 degrees per second. Participants were instructed to contract as hard and as fast as possible, to examine the strength through a range of motion at different speeds. Each participant was allowed to rest between each set. To start the work set, leg or arm was pulled back into full flexion. All Humac muscle strength testing was performed in the Neuromuscular Lab on the university campus. The order of testing flexion and extension peak and average torque for each segment was randomized.

The day following testing on the Humac machine, each participant in this study then performed a 1RM strength test to assess upper body strength using a bench press exercise, and used a leg press to assess lower body strength (Appendix G). A 1RM is the maximum amount of weight that a given muscle can move through a complete contraction (eccentric and concentric) one time, with good form. The equipment used for the upper body strength assessment was the bench press with an Olympic bar and standard weight plates ranging from 1 kilogram (kg) to 25 kg. The equipment used for the lower body strength assessment was the seated leg press using the same weight plates used for the bench press. These strength measurements were recorded to the nearest 5 kg without the assistance of a spotter. For the bench press, the participant needed to
be able to lower the bar down to the areolas, pause for a half second, and then press the bar until lockout of the elbows. For the leg press, the participant needed to lower the sled until the thigh and leg were at a 90-degree angle at the knee joint, pause for 1/2 second, and then press the sled until knee lockout. The National Strength and Conditioning Association (NSCA) guidelines were used for all testing. These guidelines required a warm up of 5-10 repetitions at 40-60% of estimated 1RM, 1 min rest with light stretching specific muscle group, 3-5 repetitions at 60-80% of estimated 1RM, increased weight conservatively with an attempt at 1RM, a 3-5 minute rest was allowed between successive attempts, continued until the participant failed to complete the lift, 1RM was required to be achieved in 3-5 attempts.

Diet Analysis

Study participants each completed a three-day food log (Appendix H) at baseline and at the midpoint of the eight-week study. They were taught how to approximate serving sizes and how to identify what was in their food so that the most accurate calorie estimations could be calculated. It was explained that the more accurate their log, the more accurate the diet analysis results would be. The food logs indicated if dietary habits changed aside from the supplement, as subjects were instructed not to change dietary habits during the study. This was done, as a means of later attributing any results seen in the dependent variables to the ingestion of the supplement along with the exercise protocol, rather than to a change in diet. Food logs were analyzed using NutritionCalc Plus (McGraw-Hill Companies, Columbus, OH, 2009) to the nearest total calorie and half of a gram of protein.
Statistical Analysis

Descriptive measures were analyzed using a split-plot repeated measures analysis of variance (ANOVA). Within and between group differences in strength, muscle hypertrophy, and body composition measurements at day 1 (baseline), day 9 (midpoint) and day 20 (following) were analyzed using split-plot repeated measures ANOVA (Weight training/supplement group x day). Significant main and interaction effects were analyzed for multiple comparisons. Statistical significance for all data analysis was accepted at the $p<0.05$ level of confidence, and power was established at $\geq .80$. Data was analyzed using Statistical Package for Social Sciences for Windows (version 22.0, 2015, IBM Corporation, Armonk, NY).
CHAPTER 4

RESULTS

Subjects

Twenty-three males who met entry criteria were selected to participate in the study. Two individuals in the WPI and one in the WC groups dropped out of the study due to conflicts between their classes and the times available to lift, whereas, one individual in the WPI group completed the 8-week study but never returned for final assessments. A total of nineteen subjects (WPI n=9 and WC n=10) completed all phases of the study. There were no statistically significant differences in age, height and body composition between groups at the beginning of the study (Table 1). Subjects were instructed at the beginning of the study to keep their food intake consistent throughout the duration of the study. Therefore, subjects completed a baseline and midpoint three-day food log to assess nutritional intake as well as ensure intake stayed consistent. Subjects were randomly assigned to receive either WPI (Dymatize Iso 100) 29 g (25 g protein, 2.7 g leucine) (n=9) or WC (Vitargo POST) 132.5 g (25 g protein, 2.7 g leucine, 88 g carbohydrate) following eccentric-only resistance training (n=10). Histograms, revealed normally distributed descriptive data, where skewness and kurtosis values were within the range of -2.00 to +2.00. Inferentially, the majority of the Kolomogorov-Smirnoff and Shapiro-Wilk tests ($p > .05$) indicated that the dependent variables of the study were normally distributed.
Table 1
Physical Characteristics of Subjects

<table>
<thead>
<tr>
<th></th>
<th>WPI (n=9)</th>
<th>WC (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>21.11 ± 1.62</td>
<td>21.50 ± 2.27</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>177.80 ± 5.59</td>
<td>179.07 ± 3.63</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>79.44 ± 8.25</td>
<td>86.07 ± 15.29</td>
</tr>
<tr>
<td>Body Fat (%)</td>
<td>15.16 ± 6.65</td>
<td>16.33 ± 6.42</td>
</tr>
<tr>
<td>Lean Body Mass (kg)</td>
<td>147.50 ± 10.26</td>
<td>156.61 ± 16.97</td>
</tr>
</tbody>
</table>

Mean +/-SD
WPI= Whey protein isolate WC= carbohydrate and whey protein

Muscular Strength

Bench Press

A split-plot repeated measures analysis of variance found statistically significant changes in bench press (p=0.001) for the WPI group (80.30 ± 16.23 kg baseline, 78.54 ± 14.86 kg midpoint, 84.35 ± 14.08 kg final) and the WC group (103.86 ± 21.72 kg baseline, 106.36 ± 21.26 kg midpoint, 110.23 ± 19.14 kg final). Polynomial contrasts were used to assess whether effects were seen in linear or quadratic trends for each variable. The variance accounted for both the WPI and WC group was 33.90%. However, there was no time * supplement interaction effect on bench press for the groups during the 8-week study (p= 0.317, power=0.24). (Table 2).
Table 2
Strength Gains Following 8 weeks of Eccentric only Wt Training

<table>
<thead>
<tr>
<th>Variable</th>
<th>WPI (n=9)</th>
<th>WC (n=10)</th>
<th>Total (N=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench Press (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>80.30 ± 16.23</td>
<td>103.86 ± 21.72</td>
<td>92.70 ± 22.34&lt;sup&gt;a,b,c,d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Midpoint</td>
<td>78.54 ± 14.86</td>
<td>106.36 ± 21.26</td>
<td>93.18 ± 22.98</td>
</tr>
<tr>
<td>Post</td>
<td>84.35 ± 14.08</td>
<td>110.23 ± 19.14</td>
<td>97.97 ± 21.15</td>
</tr>
<tr>
<td>Leg Press (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>235.86 ± 29.32</td>
<td>272.95 ± 54.25</td>
<td>255.38 ± 47.07&lt;sup&gt;b,c,d,e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Midpoint</td>
<td>262.37 ± 53.02</td>
<td>302.73 ± 58.50</td>
<td>283.61 ± 58.21</td>
</tr>
<tr>
<td>Post</td>
<td>271.46 ± 45.19</td>
<td>322.27 ± 56.83</td>
<td>298.20 ± 56.58</td>
</tr>
</tbody>
</table>

Mean +/-SD
- Mauchly’s assumption of sphericity met (p>0.05)<sup>a</sup>
- Statistical significance between baseline and midpoint<sup>b</sup>
- Baseline < midpoint < post<sup>c</sup>
- No time*supplement interaction<sup>d</sup>
- Mauchly’s assumption of sphericity not met (p<0.05)<sup>e</sup>

**Leg Press**

There were statistically significant changes (p < .001) over time for leg press in both the WPI group (235.86 ± 29.32 kg baseline, 262.37± 53.02 kg midpoint, 271.46 ± 45.19 kg final) and the WC group (272.95 ± 54.25 kg baseline, 302.73 ± 58.50 kg midpoint, 322.27 ± 56.83 kg final). The variance accounted for both of these groups was 63.10%. There was no interaction
between supplement * time for leg press \(p=0.403\), power=0.15). (Table 2). Similar effect size and power was exhibited in the remainder of the variables in this study.

**Bench Press Relative to Body Weight**

There were statistically significant changes in bench press relative to each individuals’ body weight \(p=0.001\) for the WPI group (0.46 \(\pm\) 0.08 kg baseline, 0.45 \(\pm\) 0.07 kg midpoint, 0.48 \(\pm\) 0.07 kg final) and the WC group (0.56 \(\pm\) 0.12 kg baseline, 0.56 \(\pm\) 0.11 kg midpoint, 0.58 \(\pm\) 0.11 kg final). The variance accounted for both the WPI and WC group was 36.80%. However, there was no time * supplement interaction effect on bench press for the groups during the 8-week study \(p=0.295\), power=0.26). (Table 3).

**Leg Press Relative to Body Weight**

There were statistically significant changes \(p < .001\) over time for leg press relative to each individuals’ body weight in both the WPI group (1.35 \(\pm\) 0.19 kg baseline, 1.49 \(\pm\) 0.30 kg midpoint, 1.55 \(\pm\) 0.28 kg final) and the WC group (1.46 \(\pm\) 0.30 kg baseline, 1.60 \(\pm\) 0.28 kg midpoint, 1.70 \(\pm\) 0.27 kg final). There was no interaction between supplement * time for leg press \(p=0.606\). (Table 3).
Table 3
Strength Relative to Weight

<table>
<thead>
<tr>
<th>Variable</th>
<th>Whey (WPI) ((n=9))</th>
<th>Carbohydrate/Whey (WC) ((n=10))</th>
<th>Total ((N=19))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench Press Relative (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>0.46 ± 0.08</td>
<td>0.56 ± 0.12</td>
<td>0.51 ± 0.11(^{a,b,d})</td>
</tr>
<tr>
<td>Midpoint</td>
<td>0.45 ± 0.07</td>
<td>0.56 ± 0.11</td>
<td>0.51 ± 0.11</td>
</tr>
<tr>
<td>Post</td>
<td>0.48 ± 0.07</td>
<td>0.58 ± 0.11</td>
<td>0.53 ± 0.11</td>
</tr>
<tr>
<td>Leg Press Relative (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>1.35 ± 0.19</td>
<td>1.46 ± 0.30</td>
<td>1.41 ± 0.25(^{b,c,d,e})</td>
</tr>
<tr>
<td>Midpoint</td>
<td>1.49 ± 0.30</td>
<td>1.60 ± 0.28</td>
<td>1.55 ± 0.29</td>
</tr>
<tr>
<td>Post</td>
<td>1.55 ± 0.28</td>
<td>1.70 ± 0.27</td>
<td>1.62 ± 0.28</td>
</tr>
</tbody>
</table>

Mean +/-SD
- Mauchly’s assumption of sphericity met \((p>0.05)^{a}\)
- Statistical significance between baseline and midpoint \(^{b}\)
- Baseline < midpoint < post \(^{c}\)
- No time*supplement interaction \(^{d}\)
- Mauchly’s assumption of sphericity not met \((p<0.05)^{e}\)
Elbow Flexion

There were statistically significant changes \((p = .024)\) over time for elbow flexion in both the WPI group (69.67 ± 18.89 Nm baseline, 62.00 ± 11.36 Nm midpoint, 77.56 ± 19.13 Nm final) and the WC group (80.70 ± 8.96 Nm baseline, 79.90 ± 18.25 Nm midpoint, 87.60 ± 19.53 Nm final). There was no interaction between supplement * time for elbow flexion \((p=0.583)\). (Table 4).

Table 4
Elbow/Knee Flexion/Extension Strength Following 8 weeks of Eccentric only Wt Training

<table>
<thead>
<tr>
<th>Variable</th>
<th>WPI ((n=9))</th>
<th>WC ((n=10))</th>
<th>Total ((N=19))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elbow Flexion (Nm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>69.67 ± 18.89</td>
<td>80.70 ± 8.96</td>
<td>75.47 ± 15.19</td>
</tr>
<tr>
<td>Midpoint</td>
<td>62.00 ± 11.36</td>
<td>79.90 ± 18.25</td>
<td>71.42 ± 17.55</td>
</tr>
<tr>
<td>Post</td>
<td>77.56 ± 19.13</td>
<td>87.60 ± 19.53</td>
<td>82.84 ± 19.49</td>
</tr>
<tr>
<td>Elbow Extension (Nm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>61.11 ± 17.80</td>
<td>73.80 ± 18.06</td>
<td>67.79 ± 18.61</td>
</tr>
<tr>
<td>Midpoint</td>
<td>55.67 ± 11.86</td>
<td>80.50 ± 18.64</td>
<td>68.74 ± 19.96</td>
</tr>
<tr>
<td>Post</td>
<td>74.67 ± 25.38</td>
<td>88.00 ± 21.23</td>
<td>81.68 ± 23.63</td>
</tr>
<tr>
<td>Knee Flexion (Nm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>120.33 ± 13.16</td>
<td>111.20 ± 20.75</td>
<td>115.53 ± 17.72</td>
</tr>
<tr>
<td>Midpoint</td>
<td>117.00 ± 27.87</td>
<td>105.20 ± 25.45</td>
<td>110.79 ± 26.57</td>
</tr>
<tr>
<td>Post</td>
<td>127.78 ± 15.41</td>
<td>121.30 ± 17.06</td>
<td>124.37 ± 16.19</td>
</tr>
<tr>
<td>Knee Extension (Nm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>268.67 ± 60.79</td>
<td>293.50 ± 69.21</td>
<td>281.74 ± 64.81</td>
</tr>
<tr>
<td>Midpoint</td>
<td>246.00 ± 54.51</td>
<td>289.80 ± 69.10</td>
<td>269.05 ± 64.91</td>
</tr>
<tr>
<td>Post</td>
<td>294.11 ± 48.23</td>
<td>302.80 ± 65.89</td>
<td>298.68 ± 56.78</td>
</tr>
</tbody>
</table>

Mean +/-SD

Mauchly’s assumption of sphericity met \((p>0.05)\)^a
No time*supplement interaction^d
Mauchly’s assumption of sphericity not met \((p<0.05)\)^e
No statistical difference among times^f
Statistical significance between midpoint and post^g
**Elbow Extension**

There were statistically significant changes ($p = 0.003$) over time for elbow extension in both the WPI group (61.11 ± 17.80 Nm baseline, 55.67 ± 11.86 Nm midpoint, 74.67 ± 25.38 Nm final) and the WC group (73.80 ± 18.06 Nm baseline, 80.50 ± 18.64 Nm midpoint, 88.00 ± 21.23 Nm final). There was no interaction between supplement * time for elbow extension ($p=0.278$). (Table 4).

**Knee Flexion**

There were not statistically significant changes ($p = 0.024$) over time for knee flexion in both the WPI group (120.33 ± 13.16 Nm baseline, 117.00 ± 27.87 Nm midpoint, 127.78 ± 15.41 Nm final) and the WC group (111.20 ± 20.75 Nm baseline, 105.20 ± 25.45 Nm midpoint, 121.30 ± 17.06 Nm final). There also was no interaction between supplement * time for knee flexion ($p=0.841$). (Table 4).

**Knee Extension**

There were statistically significant changes ($p = 0.048$) over time for elbow flexion in both the WPI group (268.67 ± 60.79 Nm baseline, 246.00 ± 54.51 Nm midpoint, 294.11 ± 48.23 Nm final) and the WC group (293.50 ± 69.21 Nm baseline, 289.80 ± 69.10 Nm midpoint, 302.80 ± 65.89 Nm final). There was no interaction between supplement * time for elbow flexion ($p=0.348$). (Table 4).
Muscular Hypertrophy

Chest

There was a statistically significant difference within-subjects ($p=< .001$) in chest hypertrophy during the 8-week program for the WPI group (97.00 ± 5.08 cm baseline, 97.79 ± 8.15 cm midpoint, 98.63 ± 3.94 cm final) as well as the WC group (101.85 ± 9.88 cm baseline, 104.01 ± 9.42 cm midpoint, 104.27 ± 10.03 cm final). The effect size for both of these groups was 39.90%. However, there was no interaction between time * supplement ($p=0.297$, power=0.25). (Table 5).

Upper Arm

There was a statistically significant difference ($p= < .001$) in upper arm hypertrophy for the WPI (34.93 ± 3.63 cm baseline, 35.92 ± 3.91 cm midpoint, 36.47 ± 3.73 cm final) and WC groups (38.15 ± 3.48 cm baseline, 38.68 ± 3.51 cm midpoint, 38.99 ± 3.35 cm final) during the 8-week study. The effect size for both of these groups was 58.10%. There were no statistically significant differences with the time * supplement interaction ($p=.233$, power =.30). (Table 5).
<table>
<thead>
<tr>
<th>Variable</th>
<th>Whey (WPI) ((n=9))</th>
<th>Carbohydrate/Whey (WC) ((n=10))</th>
<th>Total ((N=19))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chest (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>97.00 ± 5.08</td>
<td>101.85 ± 9.88</td>
<td>99.57 ± 8.15(^{a,b,c,d})</td>
</tr>
<tr>
<td>Midpoint</td>
<td>97.79 ± 8.15</td>
<td>104.01 ± 9.42</td>
<td>101.07 ± 8.08</td>
</tr>
<tr>
<td>Post</td>
<td>98.63 ± 3.94</td>
<td>104.27 ± 10.03</td>
<td>101.60 ± 8.10</td>
</tr>
<tr>
<td><strong>Upper Arm (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>34.93 ± 3.63</td>
<td>38.15 ± 3.48</td>
<td>36.63 ± 3.81(^{a,b,c,d})</td>
</tr>
<tr>
<td>Midpoint</td>
<td>35.92 ± 3.91</td>
<td>38.68 ± 3.51</td>
<td>37.36 ± 3.86</td>
</tr>
<tr>
<td>Post</td>
<td>36.47 ± 3.73</td>
<td>38.99 ± 3.35</td>
<td>37.85 ± 3.68</td>
</tr>
<tr>
<td><strong>Waist (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>82.55 ± 6.63</td>
<td>88.27 ± 9.93</td>
<td>85.55 ± 8.81(^{a,c,d,f})</td>
</tr>
<tr>
<td>Midpoint</td>
<td>83.34 ± 7.67</td>
<td>88.72 ± 9.12</td>
<td>86.16 ± 8.69</td>
</tr>
<tr>
<td>Post</td>
<td>83.03 ± 7.26</td>
<td>89.28 ± 10.49</td>
<td>86.33 ± 9.42</td>
</tr>
<tr>
<td><strong>Hip (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>88.54 ± 9.32</td>
<td>96.27 ± 10.90</td>
<td>92.61 ± 8.76(^{a,d,f})</td>
</tr>
<tr>
<td>Midpoint</td>
<td>90.32 ± 8.23</td>
<td>94.01 ± 9.30</td>
<td>92.25 ± 8.76</td>
</tr>
<tr>
<td>Post</td>
<td>87.71 ± 7.42</td>
<td>93.12 ± 9.07</td>
<td>90.55 ± 8.56</td>
</tr>
<tr>
<td><strong>Thigh (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>54.97 ± 4.60</td>
<td>57.79 ± 5.66</td>
<td>56.44 ± 5.23(^{a,b,c,d})</td>
</tr>
<tr>
<td>Midpoint</td>
<td>55.63 ± 4.83</td>
<td>57.40 ± 4.70</td>
<td>56.57 ± 4.72</td>
</tr>
<tr>
<td>Post</td>
<td>56.95 ± 4.01</td>
<td>58.55 ± 4.55</td>
<td>57.79 ± 4.27</td>
</tr>
</tbody>
</table>

Mean +/-SD

Mauchly’s assumption of sphericity met \((p>0.05)\)\(^a\)
Statistical significance between baseline and midpoint\(^b\)
Baseline < midpoint < post\(^c\)
No time*supplement interaction\(^d\)
No statistical difference among times\(^f\)
Waist

There was not a statistically significant difference \((p=0.417)\) in waist circumference during the 8-week program for the WPI group \((82.55 \pm 6.63 \text{ cm baseline, } 83.34 \pm 7.67 \text{ cm midpoint, } 83.03 \pm 7.26 \text{ cm final})\) as well as the WC group \((88.27 \pm 9.93 \text{ cm baseline, } 88.72 \pm 9.12 \text{ cm midpoint, } 89.28 \pm 10.49 \text{ cm final})\). A power value of \((0.18)\) was found for the two groups. There was no interaction between time * supplement \((p=0.753)\). (Table 5).

Hip

There was not a statistically significant difference \((p=0.109)\) in hip circumference during the 8-week program for the WPI group \((88.54 \pm 9.32 \text{ cm baseline, } 90.32 \pm 8.23 \text{ cm midpoint, } 87.71 \pm 7.42 \text{ cm final})\) as well as the WC group \((96.27 \pm 10.90 \text{ cm baseline, } 94.01 \pm 9.30 \text{ cm midpoint, } 93.12 \pm 9.07 \text{ cm final})\). A power value of \((0.42)\) was found for the two groups. There was no interaction between time * supplement \((p=0.144)\). (Table 5).

Thigh

There was a statistically significant difference \((p=0.022)\) in thigh hypertrophy during the 8-week program for the WPI group \((54.97 \pm 4.60 \text{ cm baseline, } 55.63 \pm 4.83 \text{ cm midpoint, } 56.95 \pm 4.01 \text{ cm final})\) as well as the WC group \((57.79 \pm 5.66 \text{ cm baseline, } 57.40 \pm 4.70 \text{ cm midpoint, } 58.55 \pm 4.55 \text{ cm final})\). The effect size for both of these groups was 20.10%. However, there was no interaction between time * supplement \((p=0.448)\). (Table 5).
Body Composition

**Body-Weight**

There were no statistically significant changes in weight (p=0.054) for the WPI group (79.44 ± 8.25 kg baseline, 80.20 ± 8.18 kg midpoint, 80.20 ± 7.65 kg final) or the WC group (86.07 ± 15.29 kg baseline, 86.79 ± 15.31 kg midpoint, 87.41 ± 16.74 kg final). There was no time * supplement interaction effect on body-weight for the groups during the 8-week study (p=0.70, power=0.10). (Table 6).

**Lean Body Mass**

There was a statistically significant increase (p<= .001) in lean body mass for the WPI (67.05 ± 4.66 kg baseline, 68.40 ± 4.87 kg midpoint, 68.59 ± 4.63 kg final) and WC group (71.19 ± 7.71 kg baseline, 72.30 ± 7.55 kg midpoint, 72.24 ± 8.34 kg final) during the 8-week program. The effect size for both of these groups was 38.10%. However, there was no interaction between time * supplement (p=0.74, power=.09). (Table 6).
<table>
<thead>
<tr>
<th>Variable</th>
<th>Whey (WPI) ((n=9))</th>
<th>Carbohydrate/Whey (WC) ((n=10))</th>
<th>Total ((N=19))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>79.44 ± 8.25</td>
<td>86.07 ± 15.29</td>
<td>82.93 ± 12.60(^{a,b,c,d,f})</td>
</tr>
<tr>
<td>Midpoint</td>
<td>80.20 ± 8.18</td>
<td>86.79 ± 15.31</td>
<td>83.67 ± 12.59</td>
</tr>
<tr>
<td>Post</td>
<td>80.20 ± 7.65</td>
<td>87.41 ± 16.74</td>
<td>84.00 ± 13.40</td>
</tr>
<tr>
<td>Lean Body Mass (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>67.05 ± 4.66</td>
<td>71.19 ± 7.71</td>
<td>69.23 ± 6.63(^{a,b,c,d})</td>
</tr>
<tr>
<td>Midpoint</td>
<td>68.40 ± 4.87</td>
<td>72.30 ± 7.55</td>
<td>70.45 ± 6.56</td>
</tr>
<tr>
<td>Post</td>
<td>68.59 ± 4.63</td>
<td>72.24 ± 8.34</td>
<td>70.51 ± 6.91</td>
</tr>
<tr>
<td>Body Fat (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>15.15 ± 6.38</td>
<td>16.33 ± 6.42</td>
<td>15.77 ± 6.38(^{a,d,f})</td>
</tr>
<tr>
<td>Midpoint</td>
<td>14.32 ± 5.88</td>
<td>15.62 ± 7.56</td>
<td>15.00 ± 6.66</td>
</tr>
<tr>
<td>Post</td>
<td>14.10 ± 6.15</td>
<td>16.19 ± 7.29</td>
<td>15.20 ± 6.67</td>
</tr>
</tbody>
</table>

Mean +/-SD

- Mauchly’s assumption of sphericity met (p>0.05)\(^a\)
- Statistical significance between baseline and midpoint\(^b\)
- Baseline < midpoint < post\(^c\)
- No time*supplement interaction\(^d\)
- Mauchly’s assumption of sphericity not met (p<0.05)\(^e\)
- No statistical difference among times\(^f\)
**Body-Fat Percentage**

There were no statistically significant changes in body fat \((p=0.111)\) for the WPI group (15.15 ± 6.38% baseline, 14.32 ± 5.88% midpoint, 14.10 ± 6.16 % final) or the WC group (16.33 ± 6.42% baseline, 15.62 ± 7.56% midpoint, 16.19 ± 7.29% final). There was also no time * supplement interaction effect on body fat for the groups during the 8-week study \((p= 0.387,\) power=0.20). (Table 6).

**Three-Day Food Log**

Food consumption remained consistent during the 8-week study (Table 7). Independent samples t-tests were conducted and there were no statistically significant mean differences \((p > .05)\) between the two supplement groups based on the food logs for Baseline kcal/kg, Baseline Protein; Week 4 Midpoint Calories, and Week 4 Midpoint Protein.
<table>
<thead>
<tr>
<th>Variable</th>
<th>WPI Supplement Group (n=9)</th>
<th>WC Supplement Group (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline kcal/kg</td>
<td>33.23</td>
<td>31.96</td>
</tr>
<tr>
<td>Baseline Protein (g/kg)</td>
<td>1.57</td>
<td>1.58</td>
</tr>
<tr>
<td>Week 4 Midpoint Calories (kcal/kg)</td>
<td>30.73</td>
<td>29.09</td>
</tr>
<tr>
<td>Week 4 Midpoint Protein (g/kg)</td>
<td>1.56</td>
<td>1.37</td>
</tr>
</tbody>
</table>
CHAPTER 5

DISCUSSION

The purpose of this study was to determine whether whey protein isolate (WPI) or a whey and carbohydrate (WC) supplement consumed following eccentric only resistance weight training sessions had an impact on muscular strength, hypertrophy, and body composition. The results of this study were intended to determine whether the WPI or WC supplements had a greater effect on muscle size and strength gains. This was the first study to directly compare the effects of a WPI and WC supplement on muscle strength, muscle hypertrophy and body composition following eccentric only resistance training. The findings of this study suggest that subjects got stronger and muscle size increased following eight weeks of eccentric only weight lifting. However, the weight lifting regimen accounted for the beneficial gains and not the supplements. Both supplemental groups had significant increases in upper body and lower body strength, muscular hypertrophy in the chest, upper arm, and thigh, as well as lean body mass because of the lifting regimen. Neither the WPI group nor WC group showed statistically significant changes in waist and hip circumference or body weight and body fat percentage. The findings of this study concur with other studies where protein supplement groups had strength increases and experienced body composition changes throughout the study which could not be attributed to the supplements consumed but the weight training regimen itself (14, 33).
Unfortunately, there are no previous studies to compare in which look at muscle hypertrophy and strength post eccentric only exercise in combination with WPI or WC supplementation.

Muscular Strength

There were statistically significant overall changes across the three points where 33.9% of the variance in Bench Press scores was explained by time. A low power 0.24 meant that there was only a 24% probability of finding an effect. Thus, there was a 76% probability of not finding an effect. The increases in strength concur with research exhibiting that individuals recruit fewer motor units during an eccentric muscle action than a concentric contraction at a given or absolute load, meaning that greater loads are required during the eccentric phase of exercise than the contraction (20). Neural efficiency of eccentrics is greater, and it has been suggested this type of resistance training maximizes strength adaptation (20). Some research has suggested that subjects may be as much as 20–60% stronger eccentrically than concentrically (20). Therefore, it seems as if an individual would be capable of eccentrically lowering a weight much heavier than they can contract, as much as 120–130% of the concentric 1RM (20). The current study had the subjects using weights at 100-125% of their 1RM, which may explain the increase in strength. There was a slight decrease seen in the mean bench press 1RM for the WPI group from baseline to midpoint, however the mean bench press then increased at final testing to be greater than baseline (80.30 ± 16.23 kg baseline, 78.54 ± 14.86 kg midpoint, 84.35 ± 14.08 kg final).

An initial thought as to why the bench press 1RM decreased at midpoint was that the subjects were experiencing soreness from the first four weeks of eccentric only exercise. The amount of soreness subjects experienced was assessed using soreness scales that the subjects
marked indicating their level of soreness each Wednesday following their Monday lifting session. To look at the scale’s score reliability, an initial, internal consistency estimate check, via Cronbach’s alpha ($\alpha$), indicated that the items on the soreness scale had $\alpha = .75$, where the recommended cut-off value for score reliability for survey research is $\alpha \geq .70$ (34). Thus, $\alpha = .75$ signified that there was high internal consistency and the items on the survey were highly intercorrelated. Additionally, aggregated and disaggregated, Pearson’s bivariate correlation tests indicated that there were no statistically significant negative relationships for the theory that as the participants’ soreness increased, their bench press would then decrease.

There was statistically significant overall change over time for elbow extension, elbow flexion and knee extension. In regard to variance, 69% of the elbow flexion, 90% of the elbow extension, and 59% of the knee extension was explained by time. This finding concurs with a study by Baroni et al. (35), which found that eccentric and isometric torques increased progressively until the end of a 12-week eccentric training program. Eccentric and isometric activation increased at weeks 4 and 8 of the Baroni et al. study, respectively, while no change was found in concentric activation (35). These results suggest that eccentric and isometric strength gains up to 8 training weeks are explained by the increased neural activation and muscle mass (35). Isokinetic dynamometry is considered the gold standard for objective muscle strength assessment, enabling a detailed evaluation of muscle function throughout the full range of motion by providing equivalent opposing torque at set testing velocities (36).
Muscular Hypertrophy

There was statistically significant overall change across the three points where 25% of the variance in chest scores, 30% of the upper arm scores and 18% of the thigh scores was explained by time. This reveals that there was at least 70% probability or more of not finding an effect for muscle hypertrophy. The findings of the current study are in direct opposition to those of Farnfield et al., who found through their research that supplementation resulted in significantly greater eccentric strength (37). The study by Farnfield et al. compared a WPI and placebo group to find the strength increases (37). Since the subjects of the current study also experienced strength gains, perhaps a supplement would have shown more significance if there had been a placebo group or a group receiving no supplement at all in which to compare. Norton and Layman (38) also suggested that leucine is an established modulator of muscle protein metabolism and is a key regulator in the translation initiation pathway of muscle protein synthesis (38). Although 2.7 g of leucine was present in both the WPI and WC supplements in the current study, perhaps a greater amount would have shown benefits from the supplementation. Consumption of 3–4 g of leucine has shown to promote maximum protein synthesis (6). According to Stark et al., an ideal supplement following resistance exercise should contain whey protein that provides at least 3 g of leucine per serving (6).

Attempting to increase the neuromuscular component of maximum strength, should be done at least 95% of the athlete's 1RM and 1 to 3 repetitions should be used (30). In order to increase the maximum strength by stimulating muscle hypertrophy, at least 80% of 1RM should be lifted 5 to 8 times or until failure (30). These guidelines may explain why muscle hypertrophy was seen during this study where each subject completed 3 sets of 6 repetitions ranging from
100-125% of their 1RM throughout the 8 weeks. The hypertrophic superiority of eccentric exercise is largely attributed to a greater muscular tension under load. It is theorized that this is because of a reversal of the size principle of recruitment, which results in fast-twitch fibers being selectively recruited (28).

There was not statistically significant change in waist and hip hypertrophy. Typically during short-term exercise regimens, such as the one employed in this study, waist circumference was expected to either decrease or remain the same. None of the exercises in the eccentric regimen from the current study targeted the abdominal muscles, leading to reasoning as to why waist circumference remained the same. For hip hypertrophy there are two muscles that play a pivotal role in strengthening of the hip. These two muscles the gluteus maximus and hip flexor were not really targeted with the eccentric only lifting regiment used in this study. Thus, this data may explain why there was not a statistically significant increase in hip circumference.

Body Composition

The body composition of the subjects changed during the eight-week resistance training protocol. The WPI group gained just under one kilogram in total body weight from the baseline measurement to the final measurement (79.44 to 80.20). The change in body weight may seem minuscule, but when looking at lean mass and body fat, the change becomes more impressive. The subjects in the WPI group increased lean body mass by approximately 1.5 kilograms (67.05 to 68.59) with an approximate one percent reduction in body fat (15.15 to 14.10). The WC group had a 1.34-kilogram increase in body weight (86.07 to 87.41), comprised of a one-kilogram gain in lean body mass (71.19 to 72.24) with only a slight decrease in body fat (16.33 to 16.19). As a
result of the excessive stress on a small number of active fibers, eccentric exercise is associated with greater muscle damage when compared to concentric and isometric contractions (28), thus indicating if there are not enough kilocalories consumed post-exercise, there may be a lack of protein synthesis (14).

The only statistical difference seen in body composition was an increase in lean body mass. There was statistically significant overall change across the three points where nine percent of the variance in the lean body mass scores was explained by time. Although there was not a significant change in body fat during the eight-week study, there was still an overall decrease in both the WPI group (15.15 ± 6.38 baseline, 14.32 ± 5.88 midpoint, 14.10 ± 6.15 post) and WC group (16.33 ± 6.42 baseline, 15.62 ± 7.56 midpoint, 16.19 ± 7.29 post). The WPI group’s body fat consistently decreased while there was a 0.71% decrease from baseline to midpoint in the WC group but a slight increase from midpoint to final testing, these differences could be due to differences in hydration. The sporadic change in body fat in the WC group may be because glycogen attracts three grams of water for every gram of glycogen, this may suggest an increased capacity for protein synthesis in those who possess greater intramuscular glycogen stores (28). Resistance exercise has been shown to induce alterations of intra- and extracellular water balance, the extent of which depends upon the type of exercise and intensity of training (28). Cell swelling is augmented by exercise that relies heavily on glycolysis, leading to lactate accumulation acting as the primary contributor to osmotic changes in skeletal muscle (28). Fast-twitch fibers are particularly sensitive to osmotic changes, presumably related to a high concentration of water transport channels. Given that fast-twitch fibers are most responsive to hypertrophy, it is likely that cellular hydration increases the hypertrophic response during resistance training that relies heavily on anaerobic glycolysis (28).
This current study concurs with Hoffman et al., who found there was no significant change in body fat percentage following a ten-week study comparing protein supplementation to a control group either pre-or post resistance training (14). The current study also concurs with research that reported the peak oxidative stress response after eccentric exercises was correlated with lean body mass (31). These data demonstrate that blood oxidative stress after low-intensity eccentric resistance exercise is related to the predominance of fast twitch muscle fiber, lean body mass, and anaerobic exercise performance (31).

Three-Day Food Log

All of the participants in the study completed a three day food log at baseline, whereas, 89% of the WPI group and 100% of the WC group completed one (excluding supplementation via the study) at the midpoint of the study. Table 6 summarizes the average calorie and protein intake for each group. While the data may not be completely accurate for each individual in the group, it serves as a generalization for how much was consumed as a whole. The two supplement groups consumed similar amounts of kilocalories (kcal) and grams of protein per kilogram (kg) of body weight. Neither group significantly increased or decreased their protein and caloric intake during the course of the study. Both groups consumed less than the recommended amount of 44-50 kcal/kg for strength-trained individuals (14). Both groups fell within the 1.2-1.7 g/kg recommended amount for strength training individuals (39). Hoffman et al. conducted a similar study in which they stated that in order for muscle hypertrophy to occur, the kcal/kg body weight must fall within the recommended amount of 44-50 (14). This may be an explanation as to why greater increases in muscular hypertrophy were not seen in this study. The subjects did not
consume enough kcal/kg body weight to maximize muscle hypertrophy. Based on current research, the WC supplement was hypothesized to produce statistically significant outcomes when compared to the WPI supplement. This is because carbohydrates aid in protein absorption, are essential to replenishing glycogen stores depleted following exercise, and therefore enhance the synthesis of muscle protein (5).

Combining the carbohydrate with whey, which has a higher bioavailability than other proteins (10), should have produced greater increases than seen in this eight week study. Furthermore, the hydrolyzed whey protein in Vitargo POST is supposedly more bioavailable than whey protein isolate, research comparing protein fractionation on the bioavailability of amino acids demonstrated significantly greater increases in plasma concentrations of amino acids following protein hydrolysates compared to non-hydrolyzed proteins (40). The use of partially hydrolyzed (pre-digested) whey protein may provide quicker delivery of amino acids to the muscle, and ultimately, more rapid recovery of force-generating capacity following muscle injury (41). Consumption of protein hydrolysate solutions, that also contain 15 g glucose, has shown peak blood insulin concentrations that are two and four times higher than after the ingestion of milk and glucose solutions (42). Consuming protein hydrolysates in post-exercise drinks can create a powerful response in blood amino acids and insulin levels without having to ingest large amounts of carbohydrates and unnecessary calories (43). By ingesting a supplement containing a whey protein hydrolysate immediately after exercise, athletes can do so without becoming bloated or suppressing their appetite; so another meal may be consumed sooner, possibly optimizing the post-exercise anabolic window (40). This study was the first to test Vitargo POST, as it was not available for purchase until this study was completed. Due to this, there are no studies in which to directly compare our results.
Conclusion

The current study investigated the effects of a whey protein isolate, and a whey/carbohydrate beverage post-eccentric exercise on muscle strength and hypertrophy in trained males. There was a statistically significant pooled average increase in muscle strength (5.27 kg bench press, 42.82 kg leg press), hypertrophy (2.03 chest cm, 1.22 arm cm, 1.35 thigh cm) and lean body mass (1.28 kg) during the eight-week eccentric resistance training study. However, the increases were due to the lifting protocol and not the supplement consumed.
CHAPTER 6

LIMITATIONS AND FUTURE RESEARCH

Limitations

The study was not adequately controlled against type II error, where there was a very high percentage probability of not finding an effect for each of the variables. This was most likely due to the small study sample size of 19. The participants in this study were all students at a university who may not have had the funds for consuming adequate calories. Aside from this, their baseline food logs were completed during the university’s homecoming; this could have had an effect on their eating habits as well as their recording of intake.

The current study did not use a control group. Since there was not a control group in the current study, although it was looked at, it was difficult to determine whether the outcomes for each variable may have been due to the supplementation rather than by the eccentric exercise protocol itself. Another limitation that may have had an effect on the outcomes was that Thanksgiving break was just before the final weeks of the study. Although the participants were given alternative exercises to do while at home for the extended weekend, there was no way of ensuring whether or not the exercises were completed. These subjects were also given a dosage of the WPI or WC supplement in a Ziploc bag to be taken after completing the exercises at
home. Moreover, there was no way of knowing whether or not the participants actually consumed their supplement at home.

Future Research

Future research should focus on student athletes in the same age range of 18-30 years old. The study should be expanded longer than 8-weeks to analyze whether a longer period of time would find statistical significance between supplementation. Using student athletes may be easier to ensure that the participants follow the protocol completely because they would not be able to go home for an extended break due to contractual rules with their sport. The athletes would also have more food availability to them due through a “training table” or a similar form of dining services providing food to student athletes. Utilizing team sports would also allow for a larger sample size, which then would have more power and possibility of finding significant findings with the Dymatize Iso 100 and Vitargo POST supplements. If having athletes participating in a training table (unlimited food and beverages available) was not feasible, it may be beneficial to conduct a study out of a University with a metabolic kitchen, which can provide the food and beverages to the subjects participating. As long as the participants are consuming enough kilocalories, there may be more significant outcomes using the Vitargo POST supplement.
REFERENCES


APPENDIX A

RECRUITMENT FLYER
Do you want to participate in a research study and increase your muscle mass?
Northern Illinois University KNPE and FCNS Research

Do I Qualify?

- Males aged 18-30 years old
- More than 1 year of weight lifting experience
- Exclusion criteria includes:
  - Use of steroids within 1 year from start of study and use of performance enhancing supplements within 6 weeks from start of the study.
  - Allergy/intolerance to whey protein, soy, gluten and/or glutamine, implanted electrical devices, sickle cell

What Do You Need To Do?

- Ability to lift three to four times per week for about an hour each session for eight weeks
- Complete three sessions of strength measurements, body circumferences, and body-fat analysis pre, midway and post intervention
- Drink a whey or soy beverage after the workout

Why? To figure out if the use of a whey beverage after weight lifting has any impact on muscle size and strength

Where will the study take place?
Depending on your availability and room availability, the workouts will take place in either the weight room in Gabel Hall or Anderson Hall

How much weight will I have to lift?
Week 1: Weight lifted is based on maximal values for 3 sets of 12 repetitions
Week 2: Weight will remain the same and 4 sets of 12 repetitions
Week 3: Sets drop back down to 3 and the repetitions are lowered to 10
Week 4: Same weight as week 3 with 4 sets of 10 then maximal weight will be recalculated
Weeks 5-8 will follow the same protocol based off of the mid-testing during the 4th week

What Will You Get?
1. Free weight lifting program designed for muscle growth
2. Free supplement for after workout
   - Immediate for experiment group
   - Delayed for control group
3. Free analysis of diet
4. Free body composition analysis at end of study

Who to Contact?
- Anthony Nielsen (KNPE): anielsen3@niu.edu
- Meagan O'Connor (FCNS): MeaganProteinStudy@gmail.com
APPENDIX B

MEDICAL HISTORY FORM
MEDICAL HISTORY FORM

Name:___________________________ Date of Birth:___________
Age: ________ Sex: M F
Height:__________ Weight:__________
Emergency Contact Person:__________________________ Phone:______________

DO YOU NOW OR HAVE YOU EVER HAD:
(Please answer YES or NO and explain any YES answers in the space provided)

PART I: KNOWN DISEASES
Do you currently have:
___ Cardiovascular disease, peripheral vascular disease, and/or cerebrovascular
disease?
___ Asthma?
___ Interstitial lung disease?
___ Cystic fibrosis?
___ Chronic Obstructive Pulmonary Disease (COPD)?
___ Diabetes (Type 1 or 2)?
___ Any thyroid disorders?
___ Renal or liver disease?

PART II: SIGNS AND SYMPTOMS
___ Do you experience pain and/or discomfort in the chest, neck, jaw, arms, or other areas
during mild exercise?
___ Do you feel short of breath at rest, with typical daily, daily activities, or with mild
exercise?
___ Do you feel short of breath while lying down flat?
___ Are you awoken in the middle of night due to feeling short of breath and/or severe
coughing/wheezing?
___ Do you often feel dizzy at rest or with mild exercise?
___ Do you suddenly pass out or lose consciousness while at rest or with mild exercise?
___ Have you experienced ankle edema (swollen ankles)?
___ Do you have heart palpitations and/or tachycardia at rest or with mild exercise?
___ Do you suffer from muscle cramping, burning, numbness, or fatigue in your calf muscles
at rest or with mild exercise?
___ Do you have a known heart murmur?
___ Do you have unusual fatigue with typical, daily activities?

PART III: CORONARY ARTERY DISEASE RISK FACTORS
___ Are you a male older than 45 years, or a female older than 55 years?
___ Do you have a close blood relative who has had a heart attack or heart surgery before the
age or 55 (Dad, brother) or age 65 (Mom, sister)?
___ Do you smoke, or did you just quit smoking within the past 6 months?
___ For the last 3 months, do you get less than 30 minutes of moderate-intense exercise, less than 3 days per week?
___ Are you at least 20lbs overweight?
___ Is your blood pressure over 140/90 mmHg, or are you on blood pressure medication?
___ Is your cholesterol greater than or equal to 200 mg/dL, or are you on cholesterol medication?
___ Is your fasting glucose greater than or equal to 100ml/dL?

**PART IV:**
Can you think of any other conditions that would be aggravated by maximal-effort exercise?

---
Are you taking prescription medications? If so, please list them and for what reasons you are taking them.

---
Do you know of **ANY OTHER REASON(S)** for why you shouldn’t partake in moderate to high-levels of intense exercise?

---

**PART V: SPECIFIC TO PROTOCOL**
___ Do you have musculoskeletal problems that limit what/how you exercise?
___ Have you had a major musculoskeletal injury (broken bones, torn ligaments/tendons, etc.) that has limited your ability to exercise in the past 12 months?
___ Have you ever experienced compartment syndrome (compression of nerves, blood vessels, and muscle tissue inside closed space or a limb)?
___ Have you ever experienced fasciotomy (fascia is cut to relieve tension/pressure due to compartment syndrome)?
___ Do you have sickle cell anemia?
___ Do you have an allergies/intolerances to whey protein, soy, gluten or glutamine?
___ Do you have any implanted electric devices?
___ Do you have at least 1 year of weight lifting / resistance training experience within the past year?

**PART VI: PROTOCOL RISKS**
Have you recently experienced:
___ Muscle trauma?
___ Muscle tears?
___ Swelling (Edema) of joints (knee, elbow)?
___ Any kind of knee/joint problems?
___ Tendonitis?
___ Cold or flu-like symptoms?
___ Other acute, short-term illness?
____ Soft tissue injury?
____ How many times have you visited the doctor in the last 12 months?
____ How many upper respiratory infections have you had in the past 12 months?
____ How many days of work/class have you missed due to illness in the past 12 months?
____ Can you think of any other condition you have that would be worsened by maximal exercise?
____ Are you aware of any other condition that may impair your ability to fully participate in exercise training, adapt properly to training, or perform fitness/strength testing (e.g., neurological, neuromuscular problems)?

If you answered YES to knee/joint problems or tendonitis, please explain: __________

____ Have you recently had bleeding gums?
____ Have you recently experienced dental work?

PART VII: MEDICATIONS
Please indicate which of the following medications you take:
____ Allergy medications?
____ Hormones?
____ Anti-depressants?
____ Anti-anxiolytic (anxiety)?
____ Pain medication (e.g., asprin, Tylenol)?
____ Anti-inflammatory (e.g., ibuprofen, aleve)?
____ Antibiotics?
____ Sleep aids (e.g., ambien, lunesta)

Please list all medications (prescription and over-the-counter) you currently take:________

Please list all vitamins and supplements you currently take (list dosage):______________

What is your daily caffeine intake? (list # of cups/bottles/cans):_____________________

Please list all ergogenic aids (performance enhancing), including those with stimulants (e.g., ephedrine, synephrine):__________________________________________

If you answered YES to any of the medications above, please complete the following section:
What medication you answered yes ____________________________
Are you currently taking the medication? __________________________
If no, how long ago did you stop? __________________________

If you have any additional medical conditions or concerns that you believe may affect your ability to participate in exercise training or testing, please describe:

____ Have you recently had a heart attack?
____ Have you been diagnosed with diabetes?
____ Have you had a stroke?
____ Have you had a seizure?
____ Have you been diagnosed with any other chronic medical condition?

Please list all current medications (prescription and over-the-counter) you take:

Please list all vitamins and supplements you currently take (list dosage):

Please list all ergogenic aids (performance enhancing) you currently use:

Please describe any additional medical conditions or concerns:

If you answered YES to any of the medications above, please complete the following section:
What medication you answered yes ____________________________
Are you currently taking the medication? __________________________
If no, how long ago did you stop? __________________________

If you have any additional medical conditions or concerns that you believe may affect your ability to participate in exercise training or testing, please describe:

____ Have you recently had a heart attack?
____ Have you been diagnosed with diabetes?
____ Have you had a stroke?
____ Have you had a seizure?
____ Have you been diagnosed with any other chronic medical condition?

Please list all current medications (prescription and over-the-counter) you take:

Please list all vitamins and supplements you currently take (list dosage):

Please list all ergogenic aids (performance enhancing) you currently use:

Please describe any additional medical conditions or concerns:

If you answered YES to any of the medications above, please complete the following section:
What medication you answered yes ____________________________
Are you currently taking the medication? __________________________
If no, how long ago did you stop? __________________________
What dosage are/were you taking? ____________________________
How long were you taking the medication? ____________________________
__ Have you had any sudden changes in diet to lose or gain weight?
__ Do you smoke now? If YES, packs per day? ___
__ Have you ever smoked in the past? If you have quit, how long ago? ___

The above facts are true to the best of my knowledge, and do not misrepresent my health in any way.

Signature of Participant: ____________________________ Date: ______
APPENDIX C

INFORMED CONSENT
Consent to Participate in the Supplement Weight Training Study

You have been invited to participate in a research project designed to test the effect of whey protein supplementation post resistance training on muscular strength, muscular growth and body composition alterations. This study is being conducted by Anthony Nielsen and Meagan O’Connor, graduate students in Kinesiology and Physical Education and Family, Consumer, and Nutrition Sciences and at Northern Illinois University under the direction of Dr. Amanda Salacinski and Dr. Judith Lukaszuk.

If you do not meet the exclusion criteria of this study, determined by a medical history form, you will not be included in this study. The exclusion criteria is determined by completing an eight-week resistance weight training program. On days 1, 28 and 56 of the study your muscular strength will be assessed by a Humac machine and having you a 1RM on bench press and leg press, muscle size will be assessed using a tape measure (arm, chest, waist, hips, and thigh) and body composition assessed using a special scale called InBody 520. The measurements will take 30-45 minutes to complete. On day 28 of the study you will need to have your strength reassessed and your workout routine adjusted accordingly to allow for further strength and hypertrophy gains. The session will take approximately 20 minutes to complete.

I understand that participation in this study will involve three-to-four one hour weight lifting sessions per week for the duration of the eight-week study at a designated area, either the weight room in Gable Hall or Anderson Hall depending on your availability and room availability. The weight lifting sessions will be individualized for you based on your day 1 strength information. On day 28 of the study your strength will be reassessed and your weight lifting routine modified accordingly to maximize strength gains. I understand that I will be expected to drink either a whey protein/carbohydrate beverage or a soy/protein beverage (as recommended by the product label on the over-the-counter powder) before leaving the training session.

I am aware that my participation is voluntary and I may withdraw at any time without penalty or prejudice, and that if I have any additional questions concerning this study, I may contact Anthony Nielsen at (815) 718-1765, Dr. Amanda Salacinski at (815) 753-5625, and/or Meagan O’Connor or Dr. Judith Lukaszuk (815) 753-6352. I understand that if I wish further information regarding my rights as a research subject, I may contact the Office of Research Compliance at Northern Illinois University at (815) 753-8588.

I understand that the intended benefits of this study include information on the effects of protein and its results on muscle. As the subject you will benefit from an exercise program designed specifically to your current fitness level, as well as receiving dietary analysis and assistance on how to eat for maximum recovery.

I understand that there is the potential risk of muscle discomfort that may result from weightlifting. This discomfort will go away after a few days. Northern Illinois University policy does not provide for compensation for, nor does the University carry insurance to cover injury or illness incurred as a result of participation in University sponsored research.
projects. Upon suffering a minor injury, subjects will be referred to NIU health services and in the event of serious injury emergency medical services will be notified immediately. Your participation is voluntary and you may withdraw at any time without penalty or prejudice.

I understand that all information gathered during this study will be kept confidential by giving all participants a number that is representative of them, and storing the information in a confidential file cabinet separate from the data, which will be locked when not in use. The eight-week exercise program results information will only be accessible by the researcher and the advisor.

I understand that my signature below is consent to participate in the Supplement Weight Training Study. I understand that my consent to participate does not constitute a waiver of any legal rights or redress I might have as a result of my participation, and I acknowledge that I have received a copy of this form.

Signature_____________________________ Date_______
APPENDIX D

COMPLETE IRB APPLICATION
Application for Institutional Review of Research

Involving Human Subjects

Note: Please complete this form thoroughly keeping in mind that the primary concern is the potential risk (economic, ethical, legal, physical, political, psychological/emotional, social, breach of confidentiality, or other) to the participants. Provide copies of all materials to be used in the investigation. The Institutional Review Board (IRB) must have enough information about the transactions with the participants to evaluate the risks of participation.

Name(s) and employee ID for faculty, Z-ID for students

<table>
<thead>
<tr>
<th>Name(s)</th>
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</thead>
<tbody>
<tr>
<td>Anthony Nielsen (z1643959), Meagan O'Connor (z1540231), Dr. Lukaszuk (r20jmy1), Dr. Amanda Salacinski (a135028)</td>
</tr>
</tbody>
</table>

Status: Faculty Graduate Student Undergraduate Student

Department:

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<th>Department</th>
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<td>KNPE and FCNS</td>
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Mailing Address (if not department):

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<tr>
<th>Mailing Address</th>
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<tbody>
<tr>
<td>204 Anderson Hall</td>
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Phone: E-mail

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<tr>
<th>Phone</th>
<th>E-mail</th>
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<tbody>
<tr>
<td>815-753-5625</td>
<td><a href="mailto:asalacinski@niu.edu">asalacinski@niu.edu</a>; <a href="mailto:jmlukaszuk@niu.edu">jmlukaszuk@niu.edu</a></td>
</tr>
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</table>

Project Title:

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<tr>
<th>Project Title</th>
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<tbody>
<tr>
<td>Effects of Weight Training and a Whey Beverage on Muscular Hypertrophy and Strength in Trained Males</td>
</tr>
</tbody>
</table>

September 2014
**Proposed Data Collection Start Date:**

**Note:** Unless the authorized departmental reviewer (e.g., chair or designee) has deemed on the screening form that IRB review is not needed, all projects must receive formal written clearance from the IRB Chair (or an IRB member designated by the Chair) **prior** to the start of data collection.

**Type of Project** (Check one)
Departmental Research (faculty/student projects not externally funded and not indicated below)

Graduate Thesis/Dissertation (IRB application should be submitted AFTER proposal defense)

| **Advisor/Committee Chair** (& e-mail): Amanda Salacinski (asalacinski@niu.edu) & Judith Lukaszuk (jmlukaszuk@niu.edu) |

Undergraduate Project (Senior thesis/capstone, research rookies, independent study)

| **Advisor/Committee Chair** (& e-mail): |

Externally Sponsored Research
A complete copy of the grant proposal or contract must accompany this application form for IRB review to take place.

| **Source of Funding:** |

| **Title of grant proposal (if different from IRB protocol):** |

- Name of principal investigator on grant proposal:

- Office of Sponsored Projects file number (Note: this is not the grant number):

| **OSP#** |

Other

| **Specify:** |
Part I. Purpose and Procedures:
a) 1) Describe the purpose of your study and the reason(s) this study is needed. Include any necessary background information and a description of your hypothesis or your research question.

Resistance training has long been sought out by many people to induce skeletal muscle hypertrophy. Muscle hypertrophy is only capable in the presence of a positive protein balance, known as protein synthesis. In order for protein synthesis to occur, one needs an elevated protein intake, especially those engaged in strength training due to exercise induced muscle damage. The timing of protein ingestion after a workout is also crucial to promote gains in strength and cross-sectional area. The purpose of this investigation is to compare the effects of protein supplementation and an 8-week eccentric (lenthening of the muscle) and concentric (shortening of the muscle) and eccentric only resistance training on changes in muscular strength and hypertrophy in trained males. It is hypothesized the subjects receiving the whey protein supplement will show greater changes in both strength and muscle cross-sectional area than those subjects receiving the soy protein supplement after 8 weeks, especially in the eccentric group.

2) The following items will help the IRB reviewers understand the step-by-step procedures of your study:

2A) Explain the participant eligibility and exclusion criteria that will be used.
Flyers will be posted in Anderson Hall, Witz Hall, the Recreation Center on the university campus, and local gyms. Interested subjects will be asked to email the researchers M. O’Connor or A. Nielsen if interested in participating in the study. Once someone is interested in participating, they will email either A. Nielsen or M. O’Connor via email, they will be contacted with the study script with more details. Please see the study script in the appendices. Interested subjects will have a time set to complete study forms and will be provided with a brief explanation of the study (see Appendix for Study Interest Script). Prior to all testing, each subject will an informed consent (see attached in appendices) and complete a Health History Questionnaire (see attached in appendices) to classify them as "low risk" healthy subjects according to the American College of Sports Medicine (ACSM). In order to be classified as "low risk" on a Medical History form participants must: answer "No" to ALL questions in Part I (known diseases), "No" to ALL questions in Part II (signs and symptoms), answer no more than one "Yes" on Part III (coronary artery disease risk factors), and is in accordance with the screening trees for aerobic exercise. Subjects will also need to answer "No" to ALL questions in Part V (specific to protocol) to meet the criteria for "low risk" for high intensity resistance training according to the strength/resistance exercise decision trees for adults. Part IV of the Medical History form, will be interpreted by the primary researcher Subjects will also be excluded if they have a history of hypertension (blood pressure greater than 140mm Hg systolic and 90mm Hg for diastolic). Participants that have diabetes will also be excluded due to abnormal glucose levels. Females will also be excluded due to the menstrual cycle and deviations in hormone levels. Subjects will not be allowed to participate within the study if they do not sign the informed consent form or do not fill out the Health History Questionnaire. The time for filling out the forms and provided a brief explanation of the study will take about 20 minutes.

2B) Explain the recruitment procedures (how will participants learn about the study?). If using the snowballing technique, please explain who contacts potential participants (other participants or the researcher). Please attach recruitment scripts, flyers, or postings [Appendix A].
Recruitment for the study will be accomplished using flyers posted in Anderson Hall, Witrz Hall, and the Recreation Center at Northern Illinois University as well as posting flyers at local gyms within a 20 mile radius of NIU. The principle investigators contact information will be provided on the flyers and participants will contact the researcher if they wish to participate in the study.

2C) Explain the consent process (verbal and/or written procedures for informing participants of the nature of the study and what they will do).

[Please attach all documents (assent, consent, parent permission – Appendix B) that are appropriate for each group of subjects participating in the study. Consent forms should be prepared for adult participants (age 18 or over). Assent forms should be prepared for minor subjects appropriate to their ages, and permission form(s) for parents or legally authorized representatives should also be prepared. For children too young to comprehend a simple explanation of participation, parental permission is sufficient only if the research will provide direct benefit to the subject, a member of the subject's family, or other children with the same condition as the subject.]

Participants will fill out and sign a consent form allowing the collected data to be included in the study. Subjects will be informed of the required protocol and all procedures that will take place (see attached Study Interest Script). There will also be a notification stating that all participation within the study is voluntary and there will be no penalty for withdrawing from the study.

2D) Describe the data collection procedures including what data will be collected, how it will be collected (include a description of any interventions to be used), the duration of participation in the study session(s), and how the session(s) will end.
An 8-week concentric only or eccentric only weight training intervention on healthy college aged males will be used to examine increases in muscle strength and size. Prior to beginning the intervention pre-test anthropometric data will be collected including height, weight, body mass index, fat mass and lean mass will be recorded in light exercise clothing and bare feet using a wall mounted stadiometer and calibrated digital scale (InBody 520, Biospace Inc, Los Angeles, CA). Weight, fat mass, percent fat and lean mass, as well as body mass index will be assessed using InBody 520. Body mass index (BMI) will be calculated using the standard equation (kilogram per meter squared). Muscle fiber hypertrophy will be assessed by using a 60-inch cloth tape. For each participant, the following body measurements will be monitored: upper arm, chest, waist, hips, and thighs. For the upper arm measurement the midpoint between the elbow joint and the glenohumeral joint and for the thigh measurement between the acetabulofemoral (hip) joint and the tibiofemoral/patellofemoral (knee) joint. For the chest, the appropriate placement will be level with the areolas following a longitudinal line around the body. Abdominal circumference will be measured with a cloth tape anteriorly halfway between the lowest portion of the ribcage and the iliac crest. Finally, the hips will be measured two inches below the iliac crest of the hips. This is the protrusion of the hips in the frontal plane of the body. Body measurements will be completed prior to the strength assessments and measured to the nearest 1/16th of an inch. The measurements will be pulled snuggly on the muscle belly but not too much so that it makes an indentation on the skin. Each participant will have upper and lower body strength assessed using the Humac dynamometer machine. The maximal strength assessments will be performed on CSMi’s Humac (Norm Testing and Rehabilitation System Computer Sports Medicine, Inc. Stoughton, MA). The machine will be calibrated according to CSMi’s user manual before each day of testing. The participants will sit with the back angle of the chair set at ninety degrees during the isometric knee extension and flexion strength assessment of the non-dominant leg and isometric testing of the bicep and tricep muscles. For the isometric knee flexors and extensors, the participants will be secured with adjustable belts across the chest, shoulders, and hips. The alignment of the lateral epicondyle of the knee to the axis of rotation will be done visually along with the ankle cuff placement superior to the lateral malleolus and checked by hand with a goniometer. The maximal isometric knee extension and flexion strength assessment will be performed three times each at a forty five degree angle and held for five seconds to measure maximal force of the extensors and flexors. Peak torque and average torque in Nm will be measured. Participants will be given fifteen seconds of rest between each trial, and will be allotted more time if needed. A warm-up set of 1 isometric contraction, at an angle of 45 degrees, will be completed for 5 seconds for before both the flexion and extension exercises. The same protocol for the arm extensors and
flexors (bicep and tricep) muscles will be analyzed for three five second isometric contractions on the non-dominant arm. Participants will also perform isokinetic muscle strength testing of the knee in a flexion/extension pattern. The work sets will be done at speeds of 60 and 210 degrees per second. Participants will be instructed to contract as hard and as fast as possible, to examine the strength through a range of motion at different speeds. The participant will be allowed to rest between each set. To start the work set, pull leg back into full flexion. All muscle strength testing will be performed in the Neuromuscular Lab in 132 Anderson Hall. This protocol for the Humac is commonly used throughout the literature. The order of testing flexion and extension peak and average torque for each segment will be randomized. Each participant in this study will perform a 1 repetition maximum (1RM) strength test to assess chest strength using a bench press exercise. A 1RM is the maximum amount of weight that a given muscle can move through a complete contraction (eccentric and concentric) one time, with proper form. The only equipment needed for the strength assessment is the bench press with an Olympic bar and the standard weight plates ranging from 2 ½ pounds to 45 pounds. These strength measurements will be recorded to the nearest 5 pounds without the assistance of a spotter. For the bench press, the participant will need to be able to lower the bar down to the areolas, pause for a half second, and then press the bar until lockout of the elbows. The National Strength and Conditioning Association (NSCA) guidelines will be used for all testing.

After all testing, the subjects will be randomly assigned into four groups; Soy-concentric (SC), Whey-concentric (WC), Soy-eccentric (SE), and Whey-eccentric (WE).

Please see the attached protocols for both the concentric and eccentric exercises in the appendices for the exercise intervention.

Diet Analysis will be performed using a 3-day food log that the participants in this proposed study will complete. They will be taught how to approximate serving sizes along with being able to identify what is in their food so that the most accurate calorie estimations can occur. It will be explained that the more accurate their log, the more accurate the diet results will be. They will also be instructed, based on their food log, on how to change their diet accordingly that way adequate calories will be consumed so that muscle growth can occur. Diets will be analyzed to the nearest total calorie and ½ of a gram of protein.
Please note: It is the researcher’s responsibility to seek out permission to use copyrighted materials. Please indicate whether you have permission to use any copyrighted materials for your project:

Yes, I have permission to use any copyrighted materials for this project
No, I do not yet have permission to use any copyrighted materials for this project
This is not relevant for the materials being used in this project

2E) If applicable, explain the procedures for providing compensation.

2F) If applicable, explain the procedures for debriefing participants. Please attach a debriefing script or sheet [Appendix D]

Reminder: As appendices to this application, attach copies of all: A) Recruitment information [script/flyer/etc.], B) Informed consent documents [assent/parent permission/scripts/etc.], C) Materials [questionnaires/surveys/interview questions/listing of all information/data to be collected/etc.], D) Debriefing information [documents/scripts], E) Referral list [if appropriate]. It is the responsibility of the researcher to obtain any relevant permission for copyrighted materials. If the research involves an oral interview or focus group discussion that could evolve as it progresses, include a list of discussion topics and any “starter” questions for each topic that can reasonably be expected to be covered. If a draft of a written questionnaire or survey is attached, it should be clearly labeled as such and a final version must be submitted before data collection begins. PLEASE NOTE THAT ANY ITEMS CAN BE ATTACHED AS SEPARATE DOCUMENTS IF NEEDED.

Part II: Research Participants

3) Participant demographics:

Gender: M F Both
Estimated age(s):

18-30

Are any subjects under age 18? Yes No
Potentially vulnerable populations (please indicate if any of the following groups are the target population of the study)
Pregnant women & fetuses
Prisoners
Decisionally impaired/mentally disabled
Specific ethnic group(s) (list in box):

If any potentially “vulnerable populations” have been indicated above, please explain the
necessity for using this particular group, or if specific groups are excluded from the
study, please indicate the exclusion criteria used.

Target number of participants in the entire study (including controls) from start to finish (keep in mind that this is just an estimate of the total):

24

4) Please explain any outside institutional (i.e., schools, hospitals) approval you will need to obtain and how approval will be sought. Provide scripts, letters, or emails providing any information that will be used to obtain needed approvals/permission. It is the responsibility of the researcher to follow all applicable policies of any outside institution(s).

n/a

Part III: Risk/Benefit assessment

5) What knowledge/benefit(s) to the field will be gained from the study?

Subjects will learn how to properly train and lift for hypertrophy, along as learn which commonly available supplement is best. Subjects will learn their body composition at the end of the study and will see the changes from pre- to post. They will also get a measure of their maximal muscle strength by the criterion test (Humac dynomometer) and the field tests of a one repetition maximum test.

6) What direct benefit(s) are there to the participant(s) (if any) from the proposed research? [For example, learning a new skill, psychological insight, teaching experience] [Please note that compensation is NOT considered a direct benefit.]

The direct benefits to the subjects include a better understanding of proper weight training regimens, analysis of their diet, positive changes to their bodies due to exercise, and exposure to a healthy non-genetically modified protein supplement. After the study is complete, all subjects will get their body composition data.

7) Describe any potential risks (breach of confidentiality, economic, ethical, legal, physical, political, psychological/emotional, social, or other) to the subjects posed by the proposed research. (Note: Some studies may have “no reasonably foreseeable risks.”) Investigators are required to report all unexpected and/or adverse events to the IRB. Therefore, it is important that you list all reasonably anticipated risks because unanticipated adverse events may need to be reported by NIU to OHRP.
There are minimal risks to this research. The acute knee extension and flexion exercise protocol for the Humac Dynamometer poses minimal risk to the knee joint as proper precautions designated by the manufacturer to minimize the risk of injuring the knee joint. Muscular pain during the knee extension and flexion protocol is another minimal risk as muscular pain is often felt during exercise as it is a normal response to unconditioned physical activity.

The maximal eccentric knee extension and flexion protocol poses minimal risk as resting blood pressure, 120mmHg for systolic and 80mmHg for diastolic, could rise on rare occasions to an unsafe level just as with any exercise, but will be monitored before the exercise sessions start and throughout the static exercise testing.

8) Federal regulations require that researchers use procedures that minimize any risks to participants. What procedures will be used to minimize each risk and/or deal with the challenge(s) stated in “7” above?
Proper exercise form will be discussed and demonstrated to all individuals within the study and all workout sessions will be monitored by the primary investigators and assistants. Proper spotting techniques will be employees according to the NSCA guidelines. The procedures that will be taken during the knee extension and flexion to minimize harm are those recommended by the manufacturer. They will be that the participant will perform a five minute warm-up prior to the exercise. Participants will be secured by a strap across the top of the thigh and the front of the shank just above the ankle to maintain proper position during the exercise. Also, the lateral epicondyle, or the side of the knee will be aligned with the axis of rotation on the dynamometer as suggested by the manufacturer to keep proper knee movement. A visual perceived muscular pain scale will be utilized throughout the test to gauge the level of pain the individual may be experiencing. Also, blood pressure will be taken throughout the protocol to ensure the participant remains within normal values (120mmHg-systolic and 80mmHg-diastolic). The test will be stopped if the participant experiences high levels of muscular pain as shown on the Pain scale, which entails the participant’s perception of excruciating pain, or one of the most painful experiences of their life. Some pain during exercise is expected as muscular pain accompanies any exercise that is unaccustomed to the individual. The test will also be stopped if blood pressure increases to abnormal levels (>90mmHg diaastolic) as this may result in serious health risk such as stroke. Questions are also asked in the medical history form under the specific to protocol section to exclude those with a chance of experiencing rhabdomyolosis or those will sickle cell with hypertrophy training.

The researcher will discuss the normal sensation of muscle soreness and assure each participant that the soreness is a completely normal feeling.

Exclusion from the study will be those with food allergies/intolerances to whey, Soy, gluten, or glutamine to ensure subjects have no reactions to the protein supplement, also those with implanted electronic devices or sickle cell anemia will be excluded as well.

9) If support services are required to minimize risk of harm to participants, explain what will be provided (list of services available – Appendix E). [A resource list for the DeKalb area is available on the ORC website – if using this, please provide a copy with your application.]
If there is any harm caused to a participant during testing they will be asked to report to NIU Health Services or a local hospital for assessment. The primary investigator and faculty are certified in First Aid and CPR. If any adverse events happen while at NIU in the Neuromuscular Lab an accident report will be completed in detail and if non-life threatening injury occurs the use of therapeutic modalities, such as ice packs, tape, wraps, and splints are located in the building. If the bodily harm is beyond the researcher’s control/expertise, medics will be called and the subject will be sent to the local hospital for treatment. The local hospital is:

**KISHWAKEE COMMUNITY HOSPITAL**

Phone: 815/756-1521
Address: One Kish Hospital Drive - DeKalb
Fee: Insurance accepted.

10) How do the potential benefits of the study justify the potential risks to the participants?

The physical changes in strength and muscle size as well as the knowledge the subjects gain due to participating in the study will should counteract the minor muscle soreness that is anticipated.

Part IV: Consent Document Variations

11) Will audio, video, or film recording be used? Yes No

If yes, specify the recording format to be used.

Please keep in mind that specific consent must be sought in the informed consent document(s) by including a separate signature/date line giving consent for recording. This is in addition to the signature/date line giving consent to participate in the research project.

12) Will this project require the use of consent/assent documents written in a language other than English? Yes No

Reminder: If non-English documents will be used, please have the document translator provide documentation (email or written) that the translation is equivalent to the English version. [This can be done after the protocol is approved in order to minimize the number of changes needed.]

13) Are you requesting a waiver of a signed informed consent document? Yes No

Please indicate the justification for requesting this waiver:
The only record linking the subject to the research would be the signed consent document and the principal risk of the research would be breach of confidentiality. The research involves minimal risk to the subjects and involves no procedures for which written consent is normally required outside of the research context (e.g., online surveys).

14) Are you requesting a **waiver/alteration** of some other aspect of the informed consent document?  
*This section is relevant for studies involving deception.*

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<th>Yes</th>
<th>No</th>
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14a) Please explain which aspects of informed consent will be missing or altered along with a justification for the change.

14b) Please explain how the project meets all of the following criteria:

1) The research presents no more than minimal risk of harm to the participants.

2) The waiver/alteration will not adversely affect the rights or welfare of the participants.

3) The research could not practicably be carried out without the waiver or alteration.

4) Whenever appropriate, the participants will be provided with additional pertinent information after participation.

15) Will any HIPAA protected health information be collected as part of the data?  

<table>
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<tr>
<th>Yes</th>
<th>No</th>
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If yes, describe the procedures for protecting the information.
16) Will any protected school records be collected as part of the data?

Yes  No  

If yes, describe the procedures for protecting the information.

Part V: Confidentiality and Anonymity

17) Will identifying information be connected to the data (even through an identification key linking identities to a pseudonym or code that is kept separate from the data)? Yes (confidential data)  No (anonymous data)

18) If you answered yes to the above question, describe precautions to insure the privacy of the subjects, and the confidentiality of the data, both in your possession and in reports and publications.

All individuals will be given a number that will correspond to their name. A master code list that will link subjects name to their study subject number. This will be used by for the data entry only and the subjects will be not be privvy to tier subject number. The list linking the data will be stored in a separate file and separate filing cabinet locked in Dr. Salacinski’s filing cabinet.

19) How will the records (data, recordings, and consent forms) be stored? Also indicate how long records will be kept and how and when they will be disposed of.

[Note: Signed informed consent documents must be maintained for 3 years following completion of the study.]
The subjects will be randomly assigned into one of four groups, Soy-concentric, Whey-concentric, Soy-eccentric, or Whey-eccentric. Their group as a whole will have their results analyzed by SPSS and compared to other groups. All individuals will be given a number that will correspond to their name. A master code list that will link subjects name to the subject's study number. This will be used by for the data entry only and the subjects will be not be privvy to their subject number. The list linking the data will be stored in a separate file and separate filing cabinet locked in Dr. Salacinski’s filing cabinet. Data and consent forms will be kept in a locked file cabinet of A. Salacinski for three years. Confidentiality will be maintained at all times, subjects will never be mentioned by name. The records will be maintained until data analysis is complete. Upon completion of the data analysis all data sheets, informed consent and medical histories will be destroyed using a paper shredder. All information on a hard drive will be deleted after 3 years.

Part VI: Does this project involving deception

Yes  No

[complete this section only if your study includes deception]

20) Describe the deception being used. Be sure to clarify whether this is deception by omission (an important aspect of the study is withheld from the participants) or commission (the participant is misled about some aspect of the study) or both.

[Complete item 14 if aspects of consent are missing.]

21) Why is deception a necessary and unavoidable component of the experimental design?

22) Debriefing of participants will be:

Immediate (directly following the research session)
Delayed

Full (all aspects of deception will be revealed)
Partial (some aspects of deception will remain unexplained)
a) If debriefing is delayed, why is the delay necessary, and when will it occur?

b) If debriefing is partial, why is the partial debriefing necessary? Would the participant be harmed in any way by full debriefing?

c) If debriefing is partial, will full debriefing occur later?

d) Does the presence of deception increase risk of harm to the participants?

e) Is the respondent free to withdraw his/her data after being fully debriefed?

23) Who will provide the debriefing?

Reminder: Please include a copy of your debriefing script/sheet with this application [Appendix D].

Part VII: Credit and Compensation
24) If participants will receive course credit for participation, please describe it below.

25) If participants will receive some other form of compensation for participation, please describe it below.
The participants will receive free supplements, and all subjects will receive free training with experienced researchers.

26) Describe any alternative tasks that will be available for participants to earn the credit or compensation.

---

**Part VIII: Conflict of interest**

27) Do any of the researchers conducting this study have any potential conflicts of interest?

   [Conflicts of interest may include financial or personal interest, or any condition in which the investigator’s judgment regarding a primary interest may be biased by a secondary interest.] Yes No

28) If **yes** to the above question, please describe the nature of the conflict of interest.

---

Please use the following link to access the NIU research conflict of interest policy:

**Part IX: Researcher Qualifications**

29) In addition to listing the investigators’ names, indicate their qualifications to conduct procedures to be used in this study (specifically describe past experience conducting research with humans or how training will occur).
Anthony Nielsen has a bachelors of health science with a minor in nutrition, as well as being a certified personal trainer through International Sports Sciences Association (ISSA). He has experience in working in the Human Performance Lab as a graduate Assistant and collects these variables in undergraduate students in the lab.
Amanda Salacinski has a Ph.D. has experience in collecting all variables requested in this protocol and will concentrate on the exercise variables of the study.
Judith Lukaszuk has experience in all variables collected and will oversee the nutrition aspect of the study.
Meagan O’Connor has a Bachelors of Science in Nutrition and Dietetics and is getting her MS will be concentrating the nutrition analysis and will be helping in data collection and data management.

30) State the date of completion of **CITI Human Subjects Protection** training program(s) for the individuals listed in the above question. [Note: NIU Policy requires that research investigators must complete appropriate training before conducting human subjects research.] If you have comparable training, please attach certification indicating this.

**CITI (Collaborative Institutional Training Initiative) training is thorough and well recognized: https://www.citiprogram.org/Default.asp?**

- Anthony Nielsen completed the Collaborative IRB Training Initiative (CITI) Program (09/04/2013).
- Amanda Salacinski has completed the Collaborative IRB Training Initiative (CITI) Program (07/08).
- Dr. Lukaszuk completed an IRB inservice by Sandra Arntz (August 2007).
- Meagan O’Connor completed the Collaborative IRB Training Initiative (CITI) Program (11/12).
REQUIRED SIGNATURES: ALL PROJECTS

CERTIFICATION
I certify that I have read and understand the policies and procedures for research projects that involve human subjects and that I intend to comply with Northern Illinois University Policy. Any changes in the approved protocol will be submitted to the IRB for written approval prior to those changes being put into practice unless it involves an immediate safety issue for the subject during a procedure. (In such instances, the researcher is required to promptly notify the IRB after the fact.) I also understand that all nonexempt projects require review at least annually.

Investigator(s) Signature(s)                                    Date

Signature of Faculty Advisor                                    Date
(Student Project Only)

Authorized Departmental Review:

Project qualifies for Administrative Review.
Cite the appropriate exempt category:
Project qualifies for Subcommittee Review.
Cite the appropriate expedited category:

Project is referred for review by the convened IRB.

__________________________
Signature of Authorized Departmental Reviewer  Printed name  Date

Return this form, together with necessary documentation, to the Office of Research Compliance, Lowden Hall, 301. For information or additional assistance with the approval process, please call the office at (815) 7538588 or access the ORC web page at www.orc.niu.edu.
APPENDIX E

ECCENTRIC WEIGHT LIFTING PROTOCOL
8-Week Resistance Training Program

Lower Body Exercises

1. Barbell squat  
2. Leg press  
3. Leg extension  
4. Stiff leg deadlift  
5. Cable leg curl

Upper Body Exercises

1. Barbell bench press  
2. Incline barbell bench press  
3. Cable chest fly  
4. Seated cable row  
5. Dumbbell row  
6. Dumbbell lateral raise  
7. Lat pulldown  
8. Barbell military press  
9. Rope cable hammer  
10. Barbell curl  
11. Barbell triceps extensions  
12. Rope triceps extensions

Week 1

Monday, Day 1 (100% of 1RM @ 4 seconds/repetition)  
1. Barbell Squat (3x6)  
2. Barbell Bench Press (3x6)  
3. Lat pulldown (3x6)  
4. Barbell Military Press (3x6)  
5. Barbell Curl (3x6)  
6. Barbell Tricep Extension (3x6)
Wednesday, Day 2 (100% of 1RM @ 4 seconds/repetition)

1. Leg Press (3x6)
2. Incline Barbell Bench Press (3x6)
3. Lat Pulldowns (3x6)
4. Barbell Military Press (3x6)
5. Barbell Curl (3x16)
6. Barbell triceps extensions (3x6)

Week 2

Monday, Day 3 (110% of 1RM @ 4 seconds/repetition)

1. Barbell Squat (3x6)
2. Barbell Bench Press (3x6)
3. Seated Cable Row (3x6)
4. Barbell Military Press (3x6)
5. Rope Cable Hammer (3x6)
6. Rope Triceps Extension (3x6)

Wednesday, Day 4 (110% of 1RM @ 4 seconds/repetition)

1. Leg Press (3x6)
2. Incline Barbell Bench Press (3x6)
3. Lat Pulldowns (3x6)
4. Dumbbell Military Press (3x6)
5. Barbell Curl (3x16)
6. Barbell triceps extensions (3x6)
**Week 3**

Monday, Day 5 (120% of 1RM @ 4 seconds/repetition)
1. Barbell Squat (3x6)
2. Barbell Bench Press (3x6)
3. Lat pulldown (3x6)
4. Barbell Military Press (3x6)
5. Rope Hammer Curl (3x6)
6. Rope Triceps Extension (3x6)

Wednesday, Day 6 (120% of 1RM @ 4 seconds/repetition)
1. Leg Press (3x6)
2. Incline Barbell Bench Press (3x6)
3. Lat Pulldowns (3x6)
4. Dumbbell Military Press (3x6)
5. Barbell Curl (3x16)
6. Barbell triceps extensions (3x6)

**Week 4**

Monday, Day 7 (125% of 1RM @ 4 seconds/repetition)
1. Barbell Squat (3x6)
2. Barbell Bench Press (3x6)
3. Lat pulldown (3x6)
4. Barbell Military Press (3x6)  
5. Barbell Curl (3x6)  
6. Barbell Triceps Extension (3x6)

Wednesday, Day 8 (125% of 1RM @ 4 seconds/repetition)

1. Leg Press (3x6)  
2. Incline Barbell Bench Press (3x6)  
3. Lat Pulldowns (3x6)  
4. Dumbbell Military Press (3x6)  
5. Barbell Curl (3x16)  
6. Barbell triceps extensions (3x6)

**Week 5**

Monday, Day 9 (100% of 1RM @ 4 seconds/repetition)

1. Barbell Squat (3x6)  
2. Stiff Leg Deadlift (3x6)  
3. Barbell Bench Press (3x6)  
4. Cable Chest Fly (3x6)

Wednesday, Day 6 (100% of 1RM @ 4 seconds/repetition)

1. Dumbbell Row (3x6)  
2. Lat Pulldown (3x6)  
3. Barbell Military Press (3x6)  
4. Dumbbell Lateral Raise (3x6)  
5. Barbell Curl (3x16)
6. Barbell triceps extensions (3x6)

Friday, Day 11 (100% of 1RM @ 4 seconds/repetition)

1. Leg Press (3x6)
2. Leg Press (3x6)
3. Cable Chest Fly (3x6)
4. Incline Barbell Bench Press (3x6)

**Week 6**

Monday, Day 12 (110% of 1RM @ 4 seconds/repetition)
1. Dumbbell Row (3x6)
2. Lat Pulldown (3x6)
3. Barbell Military Press (3x6)
4. Dumbbell Lateral Raise (3x6)
5. Barbell Curl (3x16)
6. Barbell triceps extensions (3x6)

Wednesday, Day 13 (110% of 1RM @ 4 seconds/repetition)

1. Barbell Squat (3x6)
2. Cable Leg Curl (3x6)
3. Barbell Bench Press (3x6)
4. Cable Flys (3x6)

Friday, Day 14 (110% of 1RM @ 4 seconds/repetition)

1. Dumbbell Row (3x6)
2. Lat Pulldown (3x6)
3. Barbell Military Press (3x6)
4. Dumbbell Lateral Raise (3x6)
5. Barbell Curl (3x16)
6. Barbell triceps extensions (3x6)

**Week 7**

Monday, Day 15 (120% of 1RM @ 4 seconds/repetition)
1. Barbell Squat (3x6)
2. Cable Leg Curl (3x6)
3. Incline Barbell Bench Press (3x6)
4. Cable Chest Fly (3x6)

Wednesday, Day 16 (120% of 1RM @ 4 seconds/repetition)
1. Dumbbell Row (3x6)
2. Lat Pulldown (3x6)
3. Barbell Military Press (3x6)
4. Dumbbell Lateral Raise (3x6)
5. Barbell Curl (3x16)
6. Barbell triceps extensions (3x6)

Friday, Day 17 (120% of 1RM @ 4 seconds/repetition)
1. Leg Press (3x6)
2. Leg Press (3x6)
3. Cable Chest Fly (3x6)
4. Barbell Bench Press (3x6)

**Week 8**

Monday, Day 18 (125% of 1RM @ 4 seconds/repetition)
1. Dumbbell Row (3x6)
2. Lat Pulldown (3x6)
3. Barbell Military Press (3x6)
4. Dumbbell Lateral Raise (3x6)
5. Barbell Curl (3x16)
6. Barbell triceps extensions (3x6)

Wednesday, Day 19 (125% of 1RM @ 4 seconds/repetition)
1. Barbell Squat (3x6)
2. Leg Press (3x6)
3. Barbell Bench Press (3x6)
4. Cable Fly (3x6)

Friday, Day 20 (125% of 1RM @ 4 seconds/repetition)
1. Dumbbell Row (3x6)
2. Lat Pulldown (3x6)
3. Barbell Military Press (3x6)
4. Dumbbell Lateral Raise (3x6)
5. Barbell Curl (3x16)
6. Barbell triceps extensions (3x6)
EXERCISE PROTOCOL DATA SHEETS

Data Sheet

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Set 1 Weight (lbs)/ Reps (#)</th>
<th>Set 2 Weight (lbs)/ Reps (#)</th>
<th>Set 3 Weight (lbs)/ Reps (#)</th>
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<tbody>
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Subject:
Date:
Week:
Day:
Time:
APPENDIX F

SORENESS SCALE
APPENDIX G

ANTHROPOMETRICS DATA SHEET
ANTROPOMETRICS DATA SHEET

Subject: _____
Age: _____
Lifting Experience: _____ (years) ________ (average days/per within the last 6 months)

Ethnicity
_____ Caucasian/Non-Hispanic
_____ Hispanic
_____ African American
_____ Asian
_____ Native American
_____ Other Please Specify____________________

Anthropometric Measurements

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Day 1</th>
<th>Day 9</th>
<th>Day 20</th>
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</thead>
<tbody>
<tr>
<td>Chest (in)</td>
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<td>Upper Arm (in)</td>
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<td>Waist (in)</td>
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<td>Hips (in)</td>
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<tr>
<td>Thighs (in)</td>
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</table>

Body Composition

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<th>Measurement</th>
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<th>Day 20</th>
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</thead>
<tbody>
<tr>
<td>Body-fat Percent</td>
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<td>Lean Body Mass (lbs)</td>
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<td>Weight (lbs)</td>
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Strength Measurements
<table>
<thead>
<tr>
<th>Measurement</th>
<th>Day 1</th>
<th>Day 9</th>
<th>Day 20</th>
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</thead>
<tbody>
<tr>
<td>Bench Press (lbs)</td>
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<tr>
<td>Leg Press (lbs)</td>
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</tbody>
</table>
APPENDIX H

THREE-DAY FOOD LOG
## Dietary Food Log

**Subject:**
**Date:**
**Day of the Week:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Food Type and Quantity</th>
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