The Effect of an Acute Bout of Cardiovascular Exercise on Strength in Female Athletes

by

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The Requirements for the Master of Science in Exercise Science Degree

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Approved:

Date	Thesis Advisor
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Date	Associate Dean, Professional Studies

Abstract

The purpose of this study was to determine whether a bout of cardiovascular exercise would affect a trained female athlete's strength. Women varsity basketball players from SUNY Cortland (n = 9, age 19.56 ±1.33 years) volunteered for this study. The subjects completed a high intensity interval cardiovascular workout on a treadmill followed by strength testing. The strength tests included flat bench press and leg press performed four and 16 hours, after completing the bout of cardiovascular exercise, respectively. The results concluded that four hours after the cardiovascular workout, there was significant decrease in the athlete's leg press strength ($F_{(1.182, 12.999)} = 50.05$, $p < .05$, partial $\eta^2 = .820$). This decrement was only seen in the third set. By 16 hours post-cardiovascular exercise, the decrement had returned to normal. It was concluded that high intensity cardiovascular exercise can negatively affect a trained athlete's strength when performed concurrently with strength training.

Acknowledgements

To my committee: Dr. Phil Buckenmeyer, Dr. Joy Hendrick and Dr. Peter McGinnis; thank you for your patience, time and guidance. Without you, none of this would have been possible and I am forever indebted to you for all you have done for and taught me.

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Chapter I

Introduction

Background

Concurrent training has been a topic of research for the last thirty years (Davis, Wood, Andrews, Elkind & Davis, 2008). Due to conflicting results in previous studies including Sporer and Wenger (2003), Shaw, Shaw, & Brown (2009) and Levin et al. (2009), there are still questions about the effectiveness of cardiovascular exercise performed concurrently with strength training.

It is not uncommon for athletes participate in more than one sport or activity. Each sport has its own set of physiological demands such as endurance, power, strength, or speed, which it places on participants. Some sports such as basketball or ice hockey pose both endurance as well as strength and power demands within one sport. No two sports have the same set of physiological requirements; therefore those who choose to participate in multiple sports may be forced to train themselves for seemingly conflicting physiological needs. To meet these varied physiological demands, a concurrent training program attempts to improve both muscular strength and cardiovascular endurance at the same time (Leveritt, Abernethy, Barry, and Logan, 1999). However, researchers have questioned the impairment of muscular strength gains from a concurrent exercise program (Leveritt, et al., 1999).

Research by Leveritt, et al (1999), Kravitz (2004) and Sporer and Wenger, (2003) have shown that a decrease in strength performance when endurance exercise is performed prior to strength training. Another question to be answered is how long this strength decrement, caused by endurance exercise, last. However, these same studies have performed testing on untrained or recreationally-trained subjects only. Studies by Levin, G., Mcguigan, M., and Laursen, P. (2009), Wong, Chaouachi, Chamari, Dellal and Wisloff (2010) and Gallagher, DiPietro, Visek, Bancheri and Miller (2010) were performed on trained athletes with differing results.

With as many multi-sport athletes as there are today, this problem needs to be researched and understood fully. Training protocols can then be developed to gain maximum benefits of both strength and endurance training.

Statement of the Problem

The purpose of this study was twofold. First, to determine if strength was decreased by prior endurance exercise in trained athletes; and second, if there was a decrement, to determine how long did this decrement lasted in trained athletes.

Null Hypothesis

The following null hypothesis was used in this study:

1. There would be no decrement in upper body strength following the bout of endurance exercise in trained athletes.

Hypotheses

The following hypotheses used for this study were:

1. There would be a decrement in leg strength performance following the bout of endurance exercise.
2. The decrement in leg strength, following the bout of endurance exercise, would last between four and 16 hours.

Assumptions

It was assumed that:

1. Participants would give their best efforts when performing exercise protocols.
2. Participants would follow all given instructions.
3. Participants would not perform any type of exercise during designated recovery periods.

Delimitations

The following delimitations are set for this study:

1. Only college-aged (18-21) women were used for this study.
2. Only Division III varsity basketball players were used for this study
3. Strength testing was performed on the same machine for all test subjects.
4. Endurance exercise intensities were determined by pre-test results.
5. Testing was performed two weeks after the season concluded.

Limitations

The following limitations were accepted:

1. Subjects of this study participated on volunteer basis, and were randomly assigned to testing groups.
2. Physical injury or sickness may have affected the subject’s ability to perform their exercise protocol.
3. Time of day was determined by recovery periods and may fall outside the athletes normal exercise routine

4. The subjects were not in season during the study and may not be in their peak physical shape

Definition of Terms

The following terms were defined for this study as:

Concurrent training: An exercise training program, which includes both cardiovascular endurance and strength exercises (Kravitz, 2004).

High intensity interval training: Performing many short bouts of exercise above 85% of VO_2 max (Kravitz, 2004).

Significance of the Study:

Coaches are looking for the most time efficient way to train their athletes. If shown to be effective, concurrent training could be a useful tool to attain optimal results in minimum amount of time. This study is significant because trained athletes were subjects. Untrained or sedentary people were subjects of similar studies such as Shaw, & Brown (2009). Another significance is that Davis, et al. (2008) is the only other study found to also study college aged female athletes.

Chapter II

Review of Literature

Previous studies by Kravitz (2004), Wong et al. (2010) and Gallagher et al. (2010) have returned conflicting results on the effectiveness of concurrent training. Each study varies slightly from the next in their methods, subject choices, and the explanation for their results.

There are several theories that explain how concurrent training may impair strength gains. These reasons have included: (1) increased fatigue, (2) greater catabolic state, (3) differences in motor unit recruitment patterns, and (4) possible shift in fiber type (Docherty & Sporer, 2000). These reasons can be classified into two categories: chronic or acute. "Chronic" hypotheses suggest that the muscle cannot adapt metabolically or morphologically to concurrent training because of the different adaptations that are being demanded of the muscle. The "acute" hypotheses argue that strength training is compromised by the lingering fatigue resulting from endurance training (Docherty & Sporer, 2000).

Leveritt and Abernethy (1999) conducted a study to determine the acute effects of high-intensity endurance exercise on ensuing resistance activity. This study was based on an acute fatigue hypothesis, which explains the occurrence of strength inhibition during concurrent training. The hypothesis states that the residual fatigue from the endurance component of concurrent training reduces the tension developed during the strength element of concurrent training. When muscle exercises "aerobically" it becomes fatigued due to decreased amounts of energy stores within the muscle itself. When these energy stores in the muscle are depleted, the body must go elsewhere for energy;

therefore taking more time for that energy source to reach the muscle. This study consisted of six subjects and was administered in two sessions at least five days apart. One testing period was performed under control conditions, with no activity for 48 hours prior to testing. The second testing period was performed 30 minutes after a bout of high intensity endurance exercise. The endurance exercises included five, 5-minute exercise intervals performed on a cycle ergometer. Each five-minute session included one minute at 40% VO_2 max, one minute at 60%, one minute at 80%, then two minutes at 100%. There were five minutes of rest between each exercise interval. The resistance portion of the study was done with three sets of squat lifts performed at 80% of each subject's 1RM. The sets ended when a subject failed to squat to a position where the knees reached an angle of 90 degrees. Their results showed significant decreases in strength when resistance exercise was performed after an acute bout of high-intensity endurance exercise. Coaches and athletes who use concurrent training should be aware that high-intensity aerobic workouts could hinder possible strength gains. As noted by the researchers, workouts should be scheduled in such a manner that resistance training should be done at least 30 minutes following a high-intensity endurance workout or, on a different day all-together.

Leveritt, MacLaughlin and Abernethy, (2000) investigated changes in leg strength, eight and thirty-two hours, after endurance exercise, respectively. They used a randomized, cross-over design in which all participants completed both experimental and control testing. The experimental test included measuring strength at eight and thirty-two hours after a bout of endurance exercise, respectively. The control test was performed without the prior endurance activity. The protocol for the endurance exercise consisted of a 50-minute bout on a cycle ergometer. A ten-minute undulating protocol was used for intensity, and this protocol was repeated five times, with 60 seconds of rest between each ten-minute period. Isokinetic leg extension was used for strength testing. Once isokinetic peak torque was determined for six contractile speeds, sets of five consecutive maximal repetitions were performed at each contractile speed. Three minutes of rest were given between sets. The results showed that there was no significant decrease in leg strength at either eight or thirty-two hours after endurance activity. The researchers hypothesized that any decrement of leg strength after prior endurance exercise had recovered within eight hours. This study contrasts the previous research that endurance training caused a decrease in strength performance. However, there are differences between the two studies. First, the exercise protocols were not exactly the same, which could explain the contrasting results. Also, the Leveritt et al. (2000) study used subjects with extensive strength training experience. Previous research has used mostly untrained participants.

In a similar study, Kravitz (2004) investigated the effects of endurance training on strength training versus strength training alone. This study divided participants into two groups. One group followed a high-intensity interval training protocol and the second group followed a continuous, sub-maximal training protocol. The high-intensity group performed six 3-minute exercise intervals ranging from 85-100% max power output. The sub-maximal group performed 36 continuous minutes of exercise at 70% of max power output. Each of these groups also performed a strength training session four, eight, and 24 hours following their aerobic protocol, respectively. The strength training testing consisted of both incline leg press and flat bench press. The sets consisted of as many repetitions as the subject could complete at a weight equivalent to 75% of the subjects 1RM. The results at the four and eight hour marks post-exercise showed that leg press repetitions were significantly lower than control numbers. The bench press testing was not affected by the aerobic exercise. The researchers concluded that even up to eight hours following an intense bout of aerobic exercise, there is a significant decrease in leg press strength performance. It was also suggested that following a bout of aerobic exercise, a strength training session should focus on other muscle groups other than the legs.

Sporer and Wenger (2003) examined three similar questions. The first was to determine if prior aerobic exercise compromised strength performance, and if so, how long these decreases in performance lasted. The second question was to determine if the intensity of aerobic training affected subsequent strength performance. The third and final question was to see if acute strength performance is affected depending on the muscle groups used in prior aerobic exercise. Subjects were divided into two groups, group one was a high-intensity aerobic interval-training group, and group two was a sub-maximal continuous training group. Strength testing was performed based on the subjects 1 RM for the leg press and the bench press. Group one performed six three minute exercise intervals separated by a three minute rest. These six intervals were all conducted at a minimum of 85% maximum power output as determined by prior testing. Group two's aerobic bout consisted of a five-minute warm-up followed by 36 consecutive minutes of cycling at 70% of maximum power output. One repetition maximum testing was then performed at the four, eight and 24 hour marks following their aerobic exercise. The resistance portion of the study was done with four sets of leg press lifts and four sets of bench press performed at 75% of each subject's 1RM. The sets were ended when a subject failed to lower the bar until the knees reached an angle of 90 degrees. Their results showed that strength performance was significantly decreased in the leg press test following aerobic exercise, at both four and eight hours post-exercise. When 24 hours were allowed for recovery, the test results were the same as the control group (Sporer & Wenger).

All studies discussed so far tested the effect a single bout of cardiovascular exercise had on a single bout of strength training. There have been some studies performed on the long-term effects of concurrent training versus training cardiovascular or strength alone in a single-bout setting. Shaw, Shaw, and Brown (2009) performed such a study on sedentary untrained males. Through the use of a 16 week training program, the authors were able to determine that there was a significant improvement in lower body strength testing versus a control group. They were also able to determine that the strength gains made by the group performing strength training alone were matched by the concurrently trained group. They concluded that concurrent resistance and endurance training does not impede strength gains in sedentary males and can be prescribed as an effective exercise protocol (Shaw, et al. 2009).

Other studies with similar direction have been performed on trained athletes. These studies included athletes such as cyclists (Levin, McGuigan & Laursen, 2009), collegiate male rowers (Gallagher, DiPietro, Visek, Bancheri & Miller, 2010), and professional soccer players (Wong, Chaouachi, Chamari, Dellal & Wisloff, 2010). Each of these studies were directed at whether concurrent training of endurance and strength exercises increased performance of skills related to the specific sport.

Using professional soccer players, Wong et al. (2010) tested strength training and high intensity interval running concurrently versus normal soccer training. Compared to the control group, the concurrently trained group showed a significant improvement in vertical jump height, 10-meter and 30-meter sprint times, maximal aerobic speed test and maximal aerobic speed (Wong, et al. 2010). This study was performed over an eight-week period. The authors concluded that high intensity interval running can be concurrently trained with high load muscular strength training to enhance soccer players' performance and aerobic endurance.

The conclusions made by Gallagher et al. (2010) and Levin et al. (2009) both contrast with Wong et al, (2010). In testing trained collegiate male rowers, Gallagher et al. (2010) found that although all three test group rowing times were significantly improved, there was no significant difference in improvement between the groups. Levin et al. (2009) studied well-trained endurance cyclists and found similar results. The concurrently trained group in this study showed significant improvement in their 1RM squat test versus the control group. Even with this improvement in leg strength, this did not correlate to an improvement in cycling time. Both of these studies show that even though concurrent training may improve the ability to perform individual physiological requirements of a sport, those improvements do not always translate to increased performance.

Davis, et. al (2008), studied female aged college athletes. Over a 11 week exercise protocol with a concurrent training versus single mode training groups, the authors concluded that concurrent training produced significant increases in lower- (17.2%) and upper- (19.0%) body muscle strength.

Much research has been done to look at how endurance exercise affects strength performance, particularly when training for both strength and endurance simultaneously. One flaw that many of these earlier studies contain is that researchers failed to record their exact protocols. Most only reported a general description of their protocol. Replication of these studies becomes impossible making comparisons between studies unreliable. In general, it seems that much of the research shows that a bout of intense aerobic exercise does inhibit strength performance when proper recovery time is not allowed. These previous studies have also used mostly untrained or recreationally-trained subjects. Studies using trained athletes have only examined the long term effects of concurrent training on performance. Most of the earlier studies showed a decrement in strength performance following endurance exercise, but is the decrement the same for both a high intensity workout versus a sub-maximal effort workout? As stated before, the previous studies did not provide detailed protocols, therefore making it difficult to determine how much time was given between pre-testing and actual testing. Conflicting results from previous studies warrant further examination.

Chapter III

Methods

This study was designed to obtain two objectives. The first objective was to determine if previous aerobic exercise compromises strength in trained athletes, and if so, the second objective was to establish how long does this decrement lasted? To accomplish this, each subject underwent two different recovery conditions from aerobic exercise as well as a control condition of no aerobic exercise prior to strength performance.

Subjects

This study included nine subjects on a volunteer basis, all NCAA Division III women's varsity basketball players. All subjects were members of the SUNY Cortland women's basketball team aged 18-21 (mean 19.56 ± 1.33) years. Each subject read, understood and signed the informed consent form found in Appendix B.

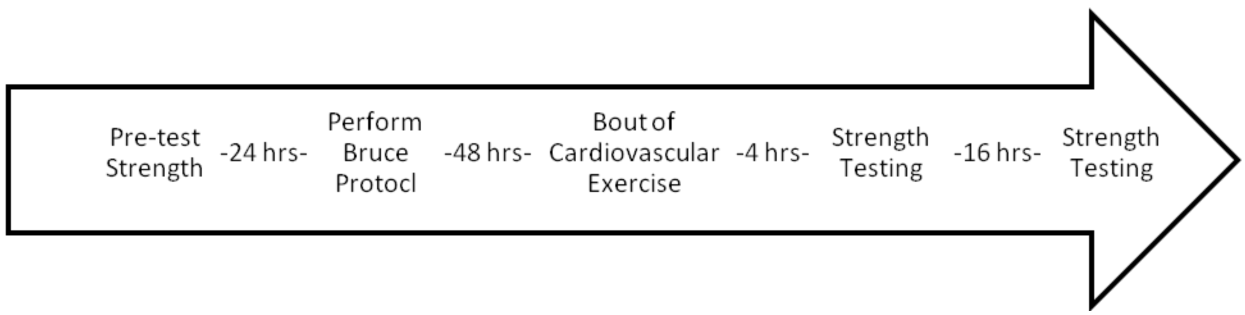
Experimental Design

Each subject was required to complete pre-testing to determine VO_2 max and max heart rate using the Bruce treadmill protocol as well as one repetition max (1RM) for both the flat bench press and for the leg press a day later.

The 1RM was determined by obtaining each subject's 10 repetition maximum and calculating their 1RM using a conversion chart (Baechle & Earle, 2000, p. 408-411). The aerobic exercise was performed on a treadmill to best simulate sport-specific training (Sporer & Wenger, 2003). Before testing began, subjects were instructed to refrain from any type of endurance or strength training for 48 hours prior to testing.

All subjects performed interval training consisting of a 5-minute warm-up and six 3-minute exercise intervals separated by three-minute recovery periods, and a five-minute cool down. During warm-up and recovery periods, training intensity was at approximately 40% of max heart rate (HR). All of the exercise intervals were performed at approximately 65-70% of maximum HR for the entire three minutes. None of the intervals were reduced below approximately 60% of maximum HR (Sporer & Wenger, 2003). Speed and slope of the treadmill was adjusted to achieve proper heart rate. The table below outlines the timeline and sequence of testing and rest periods.

Table 1: Methods Timeline



Strength Testing

Subjects were tested with two different lifts, the flat bench press and the leg press. During pre-testing, each subject completed these lifts and their 1RM was determined for each lift. Strength testing following the aerobic exercise was completed as follows. The strength testing was designed to mimic a typical resistance training session. Subjects were required to perform three sets of up to 10 repetitions of both leg press and bench press at a load of 75% of their 1RM. Three minutes of recovery were allowed between each set. All sets of leg press were completed before performing the bench press exercise. A complete repetition for the leg press was defined as the subject lowering the weight until the knees were at a 90-degree angle, and raising the weight back to the original position. Subjects were instructed by verbal command when they reached the 90-degree mark. A complete repetition for the bench press consisted of the subject lowering the bar to within 2.5 cm of the chest and raising the bar until the elbows reached full extension. Total repetitions were counted for each set and testing session. Strength testing was performed at the four (7 pm) and 16-hour (7 am) mark following their bout of aerobic exercise.

Statistical Analysis

The data analysis was performed using SPSS for windows using a Two-way within-subjects ANOVA method. Since every participant was exposed to all parts of this experiment, the within-subjects analysis was necessary. An alpha level of .05 was used for all tests.

Chapter IV

Results

The results of this experiment showed that there was no significant effect of the aerobic exercise on the first two sets of leg press lifts. However, it is clear the third set of repetitions was affected. Table 2 shows the average number of repetitions, by set, for the leg press and bench press without previous aerobic exercise:

Table 2: *Pre-Test Results*

	Bench Press			Leg Press		
	n	Reps	SD	N	Reps	SD
Set 1	9	10	±0	9	10	±0
Set 2	9	10	±0	9	10	±0
Set 3	9	10	±0	9	10	±0

Table 3 shows the average number of repetitions, by set, for leg press and bench press four hours post-aerobic exercise:

Table 3: *Four Hours Post-Aerobic Exercise*

	Bench Press			Leg Press		
	n	Reps	SD	N	Reps	SD
Set 1	9	10	±0	9	10	±0
Set 2	9	10	±0	9	10	±0
Set 3	9	9.56	± .726	9	8.67	± 1.00

When the testing was performed again 16 hours post-aerobic exercise, all numbers had returned to the same as Table 1. Since there was no difference in the raw data between the first two sets, these sets were not statistically analyzed against one another. Instead, the analysis focused on set three versus sets one and two, between the three time frames.

Statistical Analysis

The main effect of whether the cardiovascular exercise would affect bench press repetitions was not significant, $F_{(2,22)} = 1.208$, $p = .312$, partial $\eta^2 = .099$. The rules of sphericity were violated; therefore, the Greenhouse-Geisser correction was used. There was a significant main effect of the cardiovascular exercise on the four hour post-exercise lift in the third set of leg press, $F_{(1.182,\ 12.999)} = 50.05$, $p < .0005$, partial $\eta^2 = .820$.

Employing the Bonferroni post-hoc test, significant differences were found between sets two and one (p <.0005) and sets two and three (p =<.0005). There was no significant difference between sets one and three (p=.586). The partial η^2 of .82 is a strong effect size noting that 82% of the variance was accounted for by the cardiovascular exercise.

Discussion

Concurrent training is a common method of training used to condition athletes who participate in sports which demand power, speed and strength. The results of this study indicate that there is a significant effect of intense lower body cardiovascular exercise on the strength of female lower body in trained athletes. This decrease does not become apparent until the third set of strength exercise and the deficiency disappeared within 16 hours post-cardiovascular exercise. There was no significant effect of intense cardiovascular exercise on upper body strength which supports the null hypothesis. The 10 repetition limitation affected our ability to discriminate any other affects.

Both hypotheses were supported by the results. While the amount of weight to be lifted was not affected by the bout of cardiovascular exercise, the number of repetitions in the third set was significantly affected when compared to no pre-cardiovascular exercise.

The effect of the cardiovascular exercise was apparent at the four-hour post-cardiovascular test, but by the 16 hour post-cardiovascular test, results had returned to baseline. These data support the hypothesis that the strength decrement would last between four and sixteen hours.

The results of this study support the findings by Kravitz (2004), Leveritt and Abernethy (1999) and Sporer and Wenger (2003). Even though female trained athletes were used, strength decrements were found following aerobic exercise. This study also broadens the scope of previous studies by introducing female subjects. The recovery timeline is hard to distinguish in this study however, due to the fact that re-testing only took place four and 16 hours post-aerobic exercise. Another important aspect of this study was the use of female athletes as research on the effects of concurrent training on females has been minimal.

This experimental design was effective, but limited. Only one treadmill was available for use, which inhibited the ability to perform cardiovascular exercises in a timely manner. By the time the last subject was done, the first would already have about two hours of rest and that could vary results. The other part of the method that appears to be flawed was the strength training testing protocol. The test should have been designed to allow subjects to perform as many repetitions as physically possible instead of limiting them to ten. Alternatively the percentage of the one rep max used could have been increased to possibly gain a wider variety of results. The affects of upper body cardiovascular workout may have yielded differing results and should be explored further in the future.

This study differs then most of the previous studies using athletes in that strength was the unit measured. Previous studies used performance as its unit of measure. This included vertical jump height, sprint times, maximal aerobic speed testing, and time trials. Strength will positively affect all of the tests used by previous authors. Therefore determining whether strength can be improved through the use of concurrent training is important. Levin et al. (2009) and Gallagher et al (2010) both determined that significant increases in the individual units measured did not significantly improve performance. They did not investigate whether a significant increase in strength occurred which might correlate to performance.

Coaches and strength and conditioning specialists need to keep the findings of studies such as this one in mind when determining the best way to condition their athletes. Appropriate suggestions to maximize the effects of concurrent training are to (1) consider training cardiovascular and strength on different days and (2) strength train upper body muscles on days where heavy cardiovascular training is planned. While concurrent training may be a time-effective way to condition athletes, further research is needed to determine the most effective way to do so.

Chapter V

Summary, Conclusions and Recommendations

Summary

The purpose of this study was to test the effect of intense cardiovascular exercise on a trained female athlete's strength. While narrow in nature, this study examined the effect of concurrent exercise on a trained female athlete. Every subject was exposed to all aspects of the study. Pre-testing was done to determine baseline values and 1RM numbers. The subjects were then put through a high intensity interval cardiovascular workout. Subjects were then tested with flat bench press and leg press at both four and 16 hours post-cardiovascular exercise. The results from the post-cardiovascular exercise were then analyzed against the pre-testing results. Results showed a significant decrease in the subject's strength following an intense bout of aerobic exercise. This deficiency has been shown in untrained, and now in trained subjects leading to the belief that regardless of fitness level the effects of a poorly planned concurrent training program can be detrimental to performance.

Conclusions:

The following conclusions could be made based on this study:

1. A heavy bout of cardiovascular exercise impairs trained women basketball players strength.
2. The temporary strength impairment affects these athletes for at least four hours but not as long as 16 hours.
3. This study further supports the acute theory explaining why cardiovascular exercise can impair strength.

Recommendations

Further studies are required to gain a greater understanding of how to effectively train an athlete concurrently. Suggestions that can be made for future studies are:

1. Report protocols so that methods can be reproduced as closely as possible.
2. Use trained athletes, and possibly trained versus untrained athletes to further examine the difference between the recovery timelines.
3. Use athletes from multiple sports, both male and female, will make future tests more relevant to the real world.
4. Retest at more frequent intervals to narrow down the recovery timeline.
5. Use upper body cardio to see if upper and/or lower body strength is affected.

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Appendix A

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Protocol No. 05/06-S166

Please reference the protocol number in all correspondence

APPLICATION FOR REVIEW OF PROJECTS USING HUMAN RESEARCH PARTICIPANTS

SUBMIT THIS FORM WITH A COPY OF THE RESEARCH PROPOSAL TO: DIRECTOR OF SPONSORED PROGRAMS, MILLER BUILDING, ROOM 402

Investigator: Please Complete This Coversheet up to and Including the Category of Review Section

APPLICANT IS: (select one): FACULTY STUDENT (If student, please indicate faculty sponsor DR BUCKENMEYER **)**

INVESTIGATOR NAME: CHRISTOPHER WARNER DEPARTMENT: EXERCISE SCIENCE PHONE: 315-723-8583

TITLE OF PROPOSAL: Concurrent Training: Does Endurance Exersice Affect Strength Performance?

DURATION OF PROJECT: 3/06 - 7/06

(Faculty projects only): NON-FUNDED____ FUNDED____ FUNDING AGENCY:____

(Student projects only): PROJECT PURPOSE: ____Class Project X Thesis Course Number and Title EXS 650 MASTERS THESIS

The proposed investigation (or training, or demonstration program) involves the use of human research participants, and I am submitting the required information and this form to the Institutional Review Board (IRB) for the Protection of Human Research Participants for review and approval.

If the IRB approves this application and if the project is undertaken, I agree:

1. To review the Guidelines of the State University of New York at Cortland for the Protection of Human Research Participants on Research Investigations (See Research Using Human Participants at www.cortland.edu/osp).
2. To report to the IRB any change in the research plan which affects the method of using human research participants before such change is instituted.
3. To report to the IRB any problems which arise in connection with the use of human research participants.
4. To cooperate with the IRB, and/or any Sub-Committee designated, in their efforts to provide a continuing review after investigations have been initiated.
5. To furnish the IRB a brief written report on my use of human research participants immediately following completion of the project.

I agree to the principles outlined in the aforementioned Guidelines and will adhere to these ~~policies~~ and procedures in my investigation.

For Faculty Projects:

Signature of Principal Investigator Date Signature of Department Chairperson Date

For Student Projects*:* **[Note: Topics of a sensitive nature should be avoided by student researchers who are not sufficiently experienced in such research]**

Christopher Warner 3/7/06 Philip J. Buckenmeyer 3-28-06

Signature of Student Date Signature of Faculty Sponsor Date

John Cottone / 3/28/06

Signature of Department Chairperson Date

CHECK APPROPRIATE CATEGORY OF REVIEW (please see attached guidelines for information regarding categories)

Category I	(Exempt Review)	Answer questions 1-7 in the instructions and attach information and/or approvals as requested
✓ Category II	(Expedited Review)	Answer questions 1-11 in the instructions and attach information and/or approvals as requested
Category III	(Full Board Review)	Answer questions 1-16 in the instructions and attach information and/or approvals as requested

ON SEPARATE SHEET, PLEASE FURNISH THE COMPLETE INFORMATION AS REQUESTED

EXEMPT REVIEW Date
Amy Henderson-Harr, Director, OSP

APPROVED BY EXPEDITED REVIEW 4/11/06 Date
Amy Henderson-Harr, Director, OSP

CERTIFICATION OF INSTITUTIONAL REVIEW BOARD

The Institutional Review Board for the Protection of Human Participants has reviewed this application. The Board believes that the research plan provides adequate safeguards of the rights and welfare of human research participants involved in the investigation and uses appropriate methods to obtain informed consent.

4-14-06

APPROVED BY: IRB Chairperson, Date
Nancy J. Aumann, Associate Provost
for Academic Affairs

APPROVED FOR THE PERIOD OF:

4/14/06 to 7/31/06

Any changes in the protocol or extensions beyond the one year approval period must be presented in writing and approved by appropriate representatives of the IRB.

Not Approved ______

Appendix B

Informed Consent Form

This study is a research project, which will be used as part of a thesis for Christopher Warner, in the Exercise Science and Sport Studies Department at SUNY Cortland.

This project encompasses two objectives. The first objective is to investigate if a bout of endurance exercise decreases the performance in a bout of strength exercise in trained athletes, when the strength exercises are performed following the endurance bout. The second objective is, if there is a decrement in performance, how long this decrement lasts. First, all subjects will participate in a pre-testing session where baseline numbers of $V0_2$ max (aerobic capacity) and 1 RM testing for the flat bench press and the leg press will be determined. Then, 3 days later, participants will perform a high intensity interval type endurance exercise performed on a treadmill. Following the bout of endurance exercise, the subjects will be asked to perform strength exercises in the form of a leg press and a flat bench press. The strength testing will be performed at 4 and 16 hours following the bout of endurance exercise. The performance numbers following the bout of endurance exercise will be compared to pre-testing numbers and it will be determined if a decrement did occur, and if it did how long it lasted for.

Participating in this study will allow you to learn about concurrent training, and the effects of endurance exercise on strength exercise. After completing this study, you will be able to see the results, which will help you to better develop better training protocols in the future, to maximize both endurance and strength gains.

Signing this form you agree to understand the following:

a. The only foreseeable risk during this study will be you becoming fatigued toward the end of your endurance exercise. Fatigue always increases the risk of injury, but in the controlled environment of the testing, those risks will be minimized.
b. Each participant will be designated a number, which will be their identifying indicator. This number will represent that particular participant throughout the duration of this study, and these numbers will be assigned at random.
c. If any physical injury is to occur during this study, because of the fact that all participants are varsity athletes, all participants will be able to be treated in the Athletic Training facility at SUNY Cortland.
d. If you have any questions about this study, or about the rights you have as a participant in the study you may contact myself, Christopher Warner, or Dr. Buckenmeyer.
e. Your participation in this study is 100% voluntary. You are able to discontinue or refuse to participate in this study at any time you choose, without penalty, or loss of benefits, which you would otherwise be entitled to as a participant of this study.

I _______________ understand and agree to the aforementioned terms regarding this
(Print Name)
form, and by signing this form I agree to participate fully in this study.

____

(Signed Name) Date

Appendix C

Raw Data Tables:

Results for Max HR and 1RM testing

Subject	Max HR	70% Max HR	1RM BP	70% 1RM BP	1RM LP	70% 1RM LP
1	176	123.3	95	66.5	220	154
2	193	135.1	75	52.5	220	154
3	195	136.5	100	70	210	147
4	161	112.7	90	63	250	175
5	140	98	80	56	230	161
6	141	98.7	100	70	310	217
7	156	109.2	95	66.5	210	147
8	172	120.4	110	77	240	168
9	185	129.5	105	73.5	250	175

Repetitions With No Previous Aerobic Exercise

Subject	Leg Press			Bench Press		
	Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
1	10	10	10	10	10	10
2	10	10	10	10	10	10
3	10	10	10	10	10	10
4	10	10	10	10	10	10
5	10	10	10	10	10	10
6	10	10	10	10	10	10
7	10	10	10	10	10	10
8	10	10	10	10	10	10
9	10	10	10	10	10	10

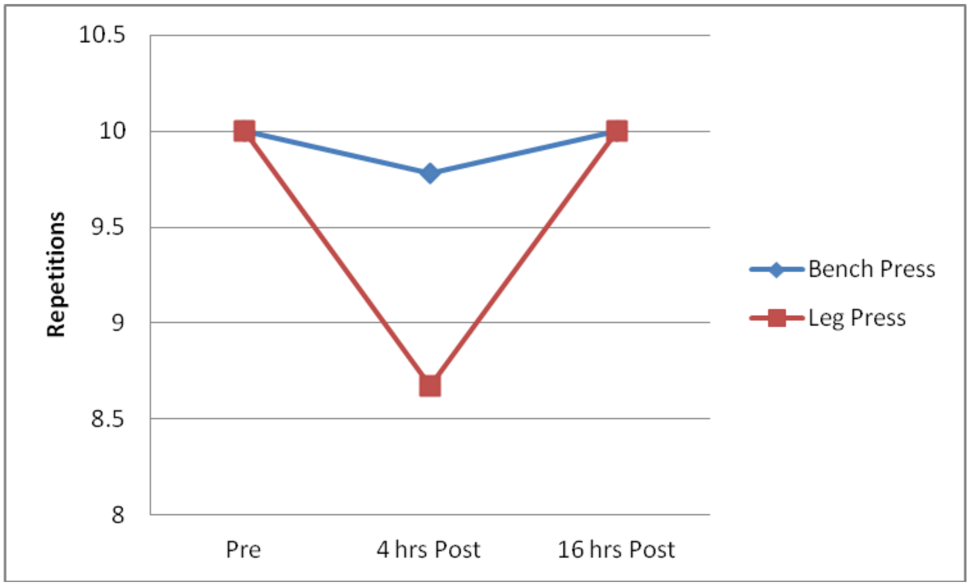
Repetitions Four hours Post-Aerobic Exercise

Subject	Leg Press			Bench Press		
	Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
1	10	10	9	10	10	10
2	10	10	8	10	10	9
3	10	10	10	10	10	10
4	10	10	8	10	10	10
5	10	10	7	10	10	10
6	10	10	9	10	10	10
7	10	10	8	10	10	10
8	10	10	9	10	10	9
9	10	10	10	10	10	10

Repetitions 16 hours Post-Aerobic Exercise

Subject	Leg Press			Bench Press		
	Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
1	10	10	10	10	10	10
2	10	10	10	10	10	10
3	10	10	10	10	10	10
4	10	10	10	10	10	10
5	10	10	10	10	10	10
6	10	10	10	10	10	10
7	10	10	10	10	10	10
8	10	10	10	10	10	10
9	10	10	10	10	10	10

Appendix D



Average Number of Set Three Repetitions for Each Testing