ACUTE EFFECTS OF EXERCISE BETWEEN SETS ON UPPER-BODY POWER

by

ANTHONY FAVA

PHILLIP A. BISHOP, COMMITTEE CHAIR
MICHAEL R. ESCO
SARA TOMEK

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ABSTRACT

Performing exercise between sets allows for increased workload in a given training session. Prior use of exercises can contribute to muscle activation or mobility which can aid in the performance of the following set. The purpose of this study was to determine the acute effects on upper-body **(UB)** power when performing different exercise types between sets. Resistance-trained (men: N = 7, age = 24 ± 2.4 years, Ht. = 176 ± 6.1 cm, Wt. = 92.5 ± 18.4 Kg, Body Comp = 18 ± 6.3 % fat; women N = 3, age = 21± 1.2 years, Ht. = 170 ± 5.1 cm, Wt. = 66.5 ± 7.16 Kg, Body Comp = 29 ± 6.0 % fat) volunteers participated in this study. All subjects underwent seven experimental trials and one familiarization trial. Each trial incorporated an exercise that was repeated between four sets of an UB-power test. The effects of six different exercises were tested. A pre-power measurement **(PreP)** was the first set prior to the start of the exercise and used as a comparison measurement. Exercise performed between sets included: resistance exercise to agonist muscle groups using suspension training **(RA)**, mild stretching exercises to agonist muscle groups **(SA)**, resistance exercise to antagonist muscle groups using suspension training **(RAnt)**, mild stretching exercises to antagonist muscle groups **(SAnt)**, plyometric to agonist muscle groups **(PlyoA)** and rest as control **(C)**. Treatments were counterbalanced and randomly assigned to participants. There was no significant effect on UB power among treatments performed (p = .080), independent of sets. There was no significant effect on UB power across sets (p = .449), independent of treatment. There was a significant interaction between treatment and sets (p = .038). UB power responded significantly different among treatments and across sets. Mean UB power (MUBP) increased from the first set to the

second set for all treatments except control. MUBP for RA and SAnt then decreased on the third set before increasing on the fourth, showing fluctuation in UB power across sets. Over time PlyoA and SA increased until the third set before decreasing on the fourth set demonstrating a ceiling effect, yet effective for early sets. MUBP for RAnt continued to increase across all sets. MUBP remained above C for all treatments for sets two, three and four except RA and the fourth set of SA.

DEDICATION

To my family, friends, supervisors, teachers and professors who supported and encouraged me over the years. Thank you God for giving me this opportunity, I hope I did all I could with this experience to make a positive difference in the world.

LIST OF ABBREVIATIONS AND SYMBOLS

UB	Upper-body
PreP	Pre power measurement
RA	Resistance to agonist muscle groups
SA	Stretching to agonist muscle groups
RAnt	Resistance to antagonist muscle groups
SAnt	Stretching to antagonist muscle groups
PlyoA	Plyometric to agonist muscle groups
C	Control
MUBP	Mean upper-body power
PP	Peak power
p	Probability associated with the occurrence under the null hypothesis which measures how extreme an observation is.
N	Sample size
Std	Standard deviation

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CHAPTER 1

INTRODUCTION

Today, college athletes in a variety of sports including American football, baseball and basketball, women's softball, volleyball and soccer are performing resistance training programs that spend less time recovering between-sets the traditional way of resting 2-5 minutes between sets of large muscle dynamic exercises. Instead the approach of performing exercises back-to-back in supersets is designed to train the different components of sport such as speed, power, strength and aerobic conditioning. This type of training allows athletes to increase their workload in a reduced amount of time, requisite for college athletes who are often time-limited. High intensity interval training (HIIT) research has shown that vigorous activity performed for a short duration can improve cardiorespiratory fitness, increase metabolic activity and promote muscle adaptation specific to demands (1, 2, 3).

CHAPTER 2

LITERATURE REVIEW

Several purposes for performing stretches, single joint exercises or a plyometric between sets of large muscle dynamic exercises e.g. bench press, squat, and Olympic lifts include: mobility for the involved muscle and joint, increased neuromuscular activity/firing rate and motor unit recruitment; (4, 5) as well as activating antagonist muscles to aid in stabilization, and speeding up agonist movement (6). In addition to increased workload and training the different components of sport, the premise of performing a specific exercise between sets is to also aid the performance of the following set, if the proper selections of exercises are made.

Previous research has investigated one exercise's acute effect on performance of another exercise as well as compared training programs with combined components to one-component programs. However, less explored are the effects on UB power when different exercises are performed between sets. Investigating these effects has greater ecological validity to programs that utilize pairing exercises such as supersets or compound sets.

Following a periodization model, training is comprised of phases that are devoted to increasing physical aspects specific to that sport, transitioning from training at high volumes at low intensities to low volumes at high intensities. Phases of a program ultimately prepare an athlete for the competitive season in which a peaking phase is achieved prior to major competitions (7). Performing exercises in supersets can support or hinder the goal of maximally increasing strength/power during the strength/power phase, depending on increases or decreases in performance throughout a training session.

According to the general adaptation syndrome, a body will adapt specifically to demands placed on it. Adhering to the stimulus-fatigue-recovery-adaptation theory, the alarm phase is the initial response to a training stimulus and results in fatigue leading to a decline in performance. "The alarm phase initiates the adaptive responses that are central to the resistance phase" or adaptation phase (9). As a result, the success of a phase can depend on the adaptive response of the body produced during a training session, allowing adequate recovery. For that reason when combining exercises, importance is placed on selecting exercises that will best promote the adaptation desired. Furthermore, the ability to increase strength/power may be jeopardized when the selection of exercises in a superset result in decreased performance, thereby preventing an athlete from achieving a specific volume and intensity associated with strength/power development. Determining the acute effects on UB power when exercises are performed between sets is useful for program design, and implementing exercises that will increase performance while increasing workload and/or addressing mobility.

Concerning the restrictions on training time allotted for college athletes, covered medical insurance sessions in physical therapies, and desire of the general population to spend short lengths of time at the gym; a goal is for increased performance or results in a shorter amount of time. Manipulating workloads to warrant greater intensities is a priority in program design relating to exercise selection, order, and rest periods.

Evaluating workloads using paired exercises will determine acute performance changes throughout a training session and provide guidance for exercise selection. Training that encompasses combinations of exercises between sets such as HIIT and CrossFit may increase aerobic thresholds and muscular fitness. Currently there is little research on the acute effects on UB power when different types of exercises are performed between sets and none that compares resistance, stretching and plyometric exercise. The purpose of this study was to evaluate the impact of resistance, stretching and plyometric exercise on acute UB power.

CHAPTER 3

METHODOLOGY

a. Background

Ten apparently healthy resistance trained men (N = 7, age = 24.1 ± 2.41 years) and women (N = 3, age = 21.3 ± 1.15 years) volunteered to participate in this study. Moderately trained individuals who had previously resistance trained for at least 6 months, 2-3 times a week were recruited. Participants were apparently healthy having no known cardiovascular, pulmonary or metabolic disease as well any orthopedic problems. Twenty-four hours prior to each test visit, participants were asked to abstain from resistance exercise or heavy activity, but to eat a small meal 2-3 hours before study trials, to consume 20 ounces of water the morning of a study trial, to sleep 6-8 hours the night before, to refrain from alcohol at least 24 hours prior and to refrain from caffeine the morning prior to study trial.

Table. 3.1 Participant characteristics (N = 10).

Subjects	Height (cm)	Weight (Kg)	Age	Body Comp (%)	Chest circ. (cm)	Upper-arm circ. (cm)	Max Push-ups (min)
MEAN	174.0	84.7	23.3	20.8	95.5	32.4	45.4
Mean Males N = 7	175.9	92.5	24.1	17.5	102.8	34.4	52.1
Std	6.12	18.43	2.48	6.31	9.35	3.56	20.85

Mean Females N = 3	169.7	66.5	21.3	28.5	78.3	27.5	29.7
Std	5.09	7.16	1.15	6.04	1.53	2.18	13.05

b. Experimental design

In a repeated-measures counterbalanced design, participants underwent one familiarization and seven experimental trials a minimum of 48 hours apart, approximately the same time of day. Written informed consent was obtained, a medical history form was completed for prescreening a participant's health based on ACSM guidelines. A 24-hour history questionnaire was used to monitor behavior prior to each trial.

Familiarization trial baseline measurements included: height, weight, body composition, upper arm and chest circumference and a maximal pushups test. Height was taken in centimeters using a stadiometer (SECA 213, Birmingham, United Kingdom). Weight was taken using a digital weighing scale (Tanita BWB-800, Tanita Corporation, Tokyo, Japan) in kilograms. Three site skinfold (SF) measurement techniques were used to assess body composition. Skinfolds were taken on the right side of the body at three sites (Jackson-Pollock 3- Site Skinfold), Males; chest/abdomen/thigh, Females; tricep/suprailliac/thigh. Upper-body circumference measurements were taken in centimeters using a body composition measuring tape (Gulick Tape, Gilroy, California). Arm circumference was measured midway between shoulder and elbow using and chest circumference at mid chest (nipple level) for males and below mid chest/inferior to breast for females. Participants then performed a maximal pushup test based on a demonstration and the following instructions, getting in a pushup position; feet together on the floor for males, knees together on the floor for females, hands shoulder width apart, arms extended, head and neck neutral to the spine and keeping body in a straight line not slumping or elevating hips. Bend elbows and lower torso until elbows are 90 degrees flexed or upper arm is parallel to the floor. Extend arms back to starting position. Perform as many as possible in 60 seconds without breaking form and only resting in an arms extended position.

After two minutes of rest, participants performed three clap-pushups as follows: in a pushup position; feet together on the floor for males, knees together on the floor with legs crossed for females, hands shoulder width apart, arms extended, head and neck neutral to the spine and keeping body in a straight line not slumping or elevating hips; bending elbows and lowering torso until elbows are 90 degrees flexed or upper arm is parallel to the floor; exploding up, extending arms, hands leaving the floor, participant clapped hands and caught themselves in the down position with elbows flexed, upper arms parallel to the floor, then immediately exploded back up to perform another clap; ending in the down position when repetitions count was achieved.

Next, the participant received a familiarization of the National Strength and Conditioning Association (NSCA) medicine ball put test. Previous upper body power research has used the bench press toss however a valid, reliable alternative is the National Strength and Conditioning Association medicine ball put (Clemons, Campbell, and Jeansonne 2010). Equipment set up for the medicine ball put consists of placing a measuring tape on the floor with the end positioned under the front frame of a workout bench, to anchor it. The workout bench was set to a 45-degree incline. The measuring tape was extended outward from the bench for at least 8 meters (26 feet), and secured to the floor. Additional procedures for the medicine ball put test are described elsewhere (NSCA's Guide to Tests and Assessments by NSCA and Todd Miller). Two throws were made; the further of the two throws used, marked by the closest part of the chalk mark on the in the direction of the bench and recorded to the nearest inch (Fig. I-IV). After practicing the medicine ball put subjects were given familiarization of the treatment protocols.

Figures 3.1-3.4 NSCA medicine ball put

Fig. 3.1

Fig. 3.2

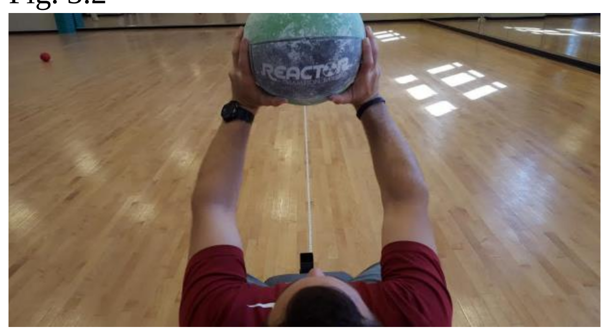


Fig. 3.3

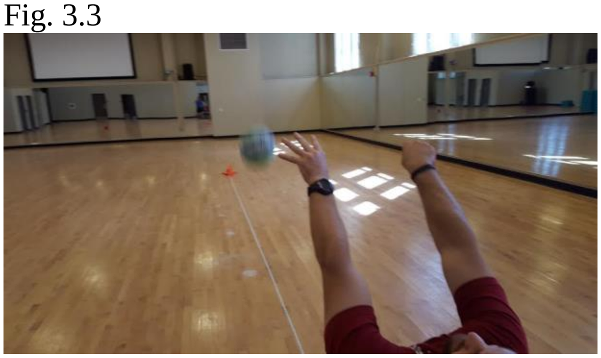


Fig. 3.4

"Figures 3.1-3.4" Photos by Seth Truhett & Anthony Fava of NSCA Medicine Ball Put Test.

Suspension training using a TRX (TRX Suspension Trainer, Fitness Anywhere LLC, San Francisco, California) was used for resistance exercises to agonist and antagonist groups. Suspension resistance training allowed desired muscle groups to be targeted, and allegedly produces greater muscle activation than traditional exercises due to instability (11, 12), a wanted outcome for possible subsequent performance enhancement. A suspension trainer was used for stretching exercises for mobility as well. The suspension device allowed the desired muscle groups to be stretched independently. Static stretching research has shown impairments in subsequent performance predominately in static stretching of long durations (≥ 90 seconds) of muscle groups (10, 14). However, static stretching of shorter durations (≤ 30 seconds) for muscle groups and those performed at slighter intensities than point of discomfort, has shown to have less to no significant effects on performance (10, 15).

Short duration static stretching (≥ 30 seconds) was used in this study with the objective of improving mobility or stimulating agonist/antagonist muscles i.e. stretch reflex, without decreasing performance. The use of short duration static stretching may also be a more applicable approach in terms of limiting rest periods in order to increase workload in given time. Static stretching can affect the length tension relationship of muscle fibers and may impair peak force output due to reduced cross bridge overlap, though it can positively impact the performance of a plyometric by lengthening the ground contact time thus increasing stored elastic energy. For this reason an individual with greater flexibility may perform better than one with limited flexibility (10). There is agreement among static stretching research (10, 16) to include flexibility training on a regular basis separately from training sessions, its role in combination with another exercise is of interest to this study (10).

An UB plyometric was implemented for specificity, an explosive movement is intended to recruit fast twitch (type IIa, type IIx) muscle fibers and increase neural output. Research has shown increased maximal voluntarily contraction following plyometrics as well as greater activation in agonist and antagonist groups. (4, 5)

The following treatments were utilized with the objective of increasing UB power:

Resistance to Agonist **(RA)**

Participants performed a pre-NSCA medicine ball put test, then three resistance exercises to agonist muscle groups on a suspension trainer (TRX Suspension Trainer, Fitness Anywhere LLC, San Francisco, California), the suspension trainer was secured using a door anchor.

The first resistance exercise was the chest press. Participant stood facing away from suspension trainer anchor point, grabbed the handles and stepped forward with straps lying over shoulders. Keeping body in a straight line, arms both straight, overhand grip/palms facing away, leaned forward until body was approximately 45 degrees to the floor, bending at the elbows and lowering body down until torso reached the handles. Then pushing back up, that completed one repetition. Participants performed five repetitions. The second resistance exercise was the Y deltoid fly. Participant stood facing suspension trainer anchor point, grabbed handles and stepped back. Keeping body in a straight line, arms extended out in front, palms facing each other; leaned back until body was approximately 45 degrees to the floor. Then raised arms both up and out forming a Y position at the top, participant rotated grip during raise so that palms were facing away at the top. Participant lowered body by bringing arms back to starting position with arms extended in front of body, palms facing each other. That completed one repetition. Participants performed five repetitions. The third resistance exercise was tricep extension. Participant stood facing away from suspension trainer anchor point, grabbed handles and stepped forward. Keeping body in a straight line, palms facing away, arms extended out and upward in front of body; leaned forward until body was approximately 45 degrees to the floor. From arms extended position, bending at the elbows, lowered down so that hands were over shoulders next to ears. Then extending arms back to starting position. That completed one repetition. Participant performed five repetitions.

Resistance exercises were performed continuously without rest. A body positioning of 45 degrees to the floor was ensured using an adjustable square, tape was used to mark foot placement at this angle. If participants could not complete all repetitions with correct form they moved their foot placement forward in one inch increments. This allowed for the smallest floor angle possible close to 45 degrees to be used, while allowing correct form to be maintained. Resistance exercises were performed at a four second eccentric phase and a two second concentric phase based on a metronome. Once participants completed the exercise protocol they immediately performed the NSCA medicine ball put test. Participants repeated the exercise protocol and medicine ball put testing twice more without rest, for a total of three rounds. Participants rested 2-5 minutes as needed and consumed water if needed before leaving.

Stretching to Agonist **(SA)**

Participants performed a pre NSCA medicine ball put test then three stretching exercises to agonist groups using a suspension trainer (TRX Suspension Trainer, Fitness Anywhere LLC, San Francisco, California), the suspension trainer was secured using a door anchor.

The first stretch was the chest stretch. Participants stood facing away from suspension trainer anchor point, using one arm, grabbed one handle in a neutral grip, stepped forward, allowing the arm holding the handle to extend back, keeping it higher than shoulder height, leaned away and forward to create tension across the chest muscle. Once in position, the investigator began a stop watch and reminded the participant it was a mild discomfort stretch. After 15 seconds, participants ended the stretch and the same procedures were used for the other arm. Participants then immediately performed the second stretch, the anterior shoulder stretch as described. Participants stood facing away from suspension trainer anchor point, grabbed both handles behind body at waist height, palms facing down. Rotated so that body was facing sideways to anchor point. During rotation the closest arm to anchor point bended at the elbow, this arm was used to keep leverage while the away arm was moved behind the back. Then stepped out allowing the suspension trainer to being hand up the back, creating tension on the away shoulder. Once in position, the investigator began a stop watch and reminded the participant it was a mild discomfort stretch. After 15 seconds, participants ended the stretch and the same procedures were used for the other arm. Participants then immediately performed the third stretch, the tricep stretch as described. Participants stood near suspension trainer, facing away from anchor point and raised one arm above and behind their head, with elbow bent, grabbed the suspension trainer strap. Participant then placed the opposite arm behind back, with elbow bent, grabbed the suspension trainer strap. Then gradually straightened the lower arm pulling on the strap creating tension on the tricep of the above arm. Once in position, the investigator began a stop watch and reminded the participant it was a mild discomfort stretch. After 15 seconds, participants ended the stretch and the same procedures were used for the other arm.

Once participants completed the exercise protocol they immediately performed the medicine ball put test. Participants repeated the exercise protocol and medicine ball put testing twice more without rest, for a total of three rounds. Participants rested 2-5 minutes as needed and consumed water if needed before leaving.

Resistance to Antagonist **(RAnt)**

Participants performed a pre-NSCA medicine ball put test as described in the familiarization trial than three resistance exercises to antagonist muscle groups on a suspension trainer (TRX Suspension Trainer, Fitness Anywhere LLC, San Francisco, California), the suspension trainer was secured using a door anchor.

The first resistance exercise was the row. Participant stood facing suspension trainer anchor point, grabbed handles and stepped back. Keeping body in a straight line, arms extended, palms facing each other, leaned back approximately 45 degrees to the floor with. Participant pulled torso towards hands keeping elbows close to the body, until chest reached hands. Participant lowered body by extending arms to starting position. That completes one repetition.

Participants performed five repetitions. The second resistance exercise was the T deltoid fly. Participants stood facing suspension trainer anchor point, grabbed handles and stepped back. Keeping body in a straight line, arms extended out in front, palms facing each other, leaned back until body was approximately 45 degrees to the floor. Participants brought arms out to the sides of the body at shoulder height, arms remained extended with palms facing forward. Participants lowered body by bringing arms back to starting position, arms extended in front of body, palms facing each other. That completed one repetition. Participants performed five repetitions. The third resistance exercise was the biceps curl. Participants stood facing suspension trainer anchor point, grabbed handles and stepped back. Keeping body in a straight line, arms extended out in front, palms facing each other; leaned back until body was approximately 45 degrees to the floor. Participants' bended elbows until hands were next to temples, rotating palms to face towards body, keeping elbows high throughout movement. Participants returned to starting position by extending elbows and rotating grip so palms faced each other. That completed one repetition. Participants performed five repetitions.

Resistance exercises were performed continuously without rest. A body positioning of 45 degrees to the floor was ensured using an adjustable square, tape was used to mark foot placement at this angle. If participants could not complete all repetitions with correct form they moved their foot placement forward in one inch increments. This allowed for the smallest floor angle possible close to 45 degrees to be used, while allowing correct form to be maintained. Resistance exercises were performed at a four second eccentric phase and a two second concentric phase based on a metronome. Once participants completed the exercise protocol they immediately performed the medicine ball put test. Participants repeated the exercise protocol and medicine ball put testing twice more without rest, for a total of three rounds. Participants rested 2-5 minutes as needed and consumed water if needed before leaving.

Stretching to Antagonist **(SAnt)**

Participants performed a pre-NSCA medicine ball put test then three stretching exercises to antagonist groups using a suspension trainer (TRX Suspension Trainer, Fitness Anywhere LLC, San Francisco, California), the suspension trainer was secured using a door anchor.

The first stretch was the lat stretch. Participant kneeled facing suspension trainer anchor point, grabbed handle with one arm palm facing down. Participant scooted back from anchor point, one arm extended holding onto handle, the other arm straight with hand on the floor. Participant sat back keeping the spine straight and lowering the torso as needed. Participants slightly shifted hips to the side opposite of extended arm, creating tension on the latissimus dorsi muscle. Once in position, the investigator began a stop watch and reminded the participant it was mild discomfort stretch. After 15 seconds, participants ended the stretch and the same procedures were used for the other side. Participants then immediately performed the second stretch, the posterior shoulder/upper back stretch as described. Participants stood facing sideways to suspension trainer anchor point. Using arm away from anchor point reached across and grabbed handle, arm in front of body. Participants arm was positioned across the chest, parallel to floor. Participants then pulled on handle and rotated slightly away from anchor point to create tension. Once in position, the investigator began a stop watch and reminded the participant it was a mild discomfort stretch. After 15 seconds, participants ended the stretch and the same procedures were used for the other side. Participants then immediately performed the third stretch, the biceps stretch as described. Participants stood facing away from suspension trainer anchor point, using one arm reached back and grabbed handle with an underhand grip. Participants stepped forward allowing the arm holding the handle to extend back and tension to develop in the suspension trainer strap. Participants kept arm extended at the elbow joint and handle at waist height. Once in position, the investigator began a stop watch and reminded the participant it was a mild discomfort stretch. After 15 seconds, participants ended the stretch and the same procedures were used for the other arm.

Once participants completed the exercise protocol they immediately performed the medicine ball put test. Participants repeated the exercise protocol and medicine ball put testing twice more without rest, for a total of three rounds. Participants rested 2-5 minutes as needed and consumed water if needed before leaving.

Plyometric to Agonist **(PlyoA)**

Participants performed a pre-NSCA medicine ball put test then an UB plyometric exercise to agonist muscle groups. Participants performed clap push-ups as described, in a pushup position; feet together on the floor for males, knees together on floor with legs crossed for females, hands shoulder width apart, arms extended, head and neck neutral to the spine, body in a straight line not slumping or elevating hips. Participants' bended elbows and lowered torso until elbows were 90 degrees flexed or upper-arms were parallel to the floor. Participants exploded up, arms extended, hands leaving the floor, clapped hands and caught themselves in the down position with elbows flexed, upper-arms parallel to the floor. Then immediately exploded back up to perform another clap; ending in the down position when repetitions count was achieved. Participants performed three repetitions. Once participants completed the exercise protocol they immediately performed the medicine ball put test. Participants repeated the exercise protocol and medicine ball put testing twice more without rest, for a total of three rounds. Participants rested 2-5 minutes as needed and consumed water if needed before leaving.

Treatments were counterbalanced and randomly assigned.

c. Statistical analysis

A 6X4 repeated measures ANOVA was used to assess differences in UB power across sets for each of the treatments. (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp). An alpha level of .05 was observed.

CHAPTER 4

RESULTS

Table 4.1 Treatment means.

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1 RA	127.375	10.370	103.918	150.832
2 SA	132.250	10.672	108.108	156.392
3 RAnt	131.475	10.897	106.824	156.126
4 SAnt	134.500	10.502	110.743	158.257
5 PlyoA	135.050	10.341	111.656	158.444
6 C	131.900	9.573	110.245	153.555

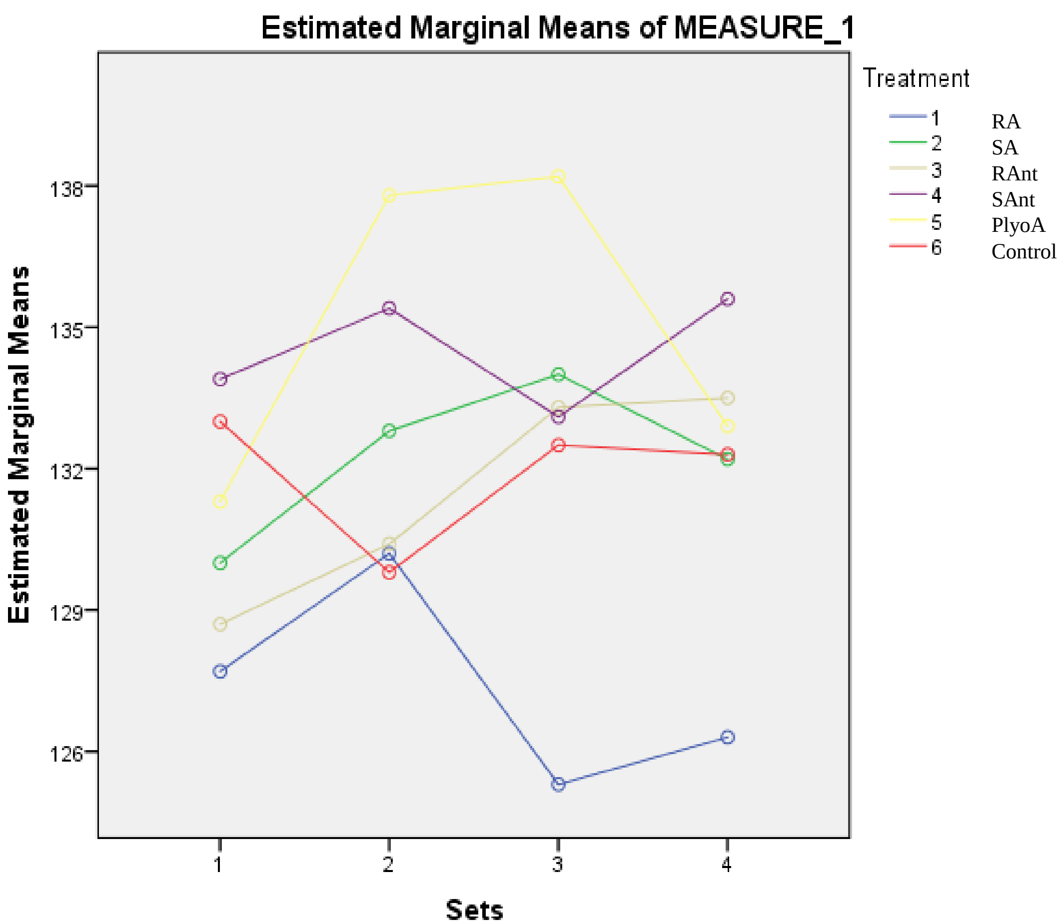
There was no significant effect on UB power among treatments performed (p = .080), independent of sets. Performing various exercises such as those depicted in this study did not significantly affect performance allowing for a similar increased workload in a given time without decreased performance.

Table 4.2 Set means.

Sets	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1 PreP	130.767	9.832	108.525	153.008
2	132.733	10.343	109.335	156.132
3	132.733	10.467	109.055	156.412
4	132.133	10.546	108.277	155.990

There was no significant effect on UB power across sets performed (p = .449), independent of treatment. Under these conditions, UB power was maintained across 4 sets.

Figure 4.1 Interaction; treatment*sets.



There was a significant interaction between treatment and sets (p = .038). UB power responded significantly different among treatments and across sets. Mean UB power (MUBP) increased from the first set to the second set for all treatments except control. MUBP for RA and SAnt then decreased on the third set before increasing on the fourth, showing fluctuation in UB power across sets. Over time PlyoA and SA increased until the third set before decreasing on the fourth set demonstrating a ceiling effect, yet effective for early sets. MUBP for RAnt continued to increase across all sets. MUBP remained above C for all treatments for sets two, three and four except RA, and the fourth set of SA. PlyoA showed the greatest early increase in UB power while RA had the greatest decrease in UB power over time. Though the trends were different the other treatments remained closer to baseline across sets.

Table 4.3 Means; treatment*sets

Treatment	Sets	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	127.700	10.350	104.288	151.112
	2	130.200	10.144	107.252	153.148
	3	125.300	10.522	101.498	149.102
	4	126.300	10.843	101.771	150.829
2	1	130.000	9.903	107.598	152.402
	2	132.800	11.190	107.486	158.114
	3	134.000	10.739	109.706	158.294
	4	132.200	11.250	106.750	157.650
3	1	128.700	10.098	105.856	151.544
	2	130.400	10.850	105.856	154.944
	3	133.300	11.442	107.417	159.183
	4	133.500	11.610	107.237	159.763
4	1	133.900	10.540	110.056	157.744
	2	135.400	10.727	111.134	159.666
	3	133.100	10.169	110.096	156.104
	4	135.600	10.847	111.063	160.137
5	1	131.300	9.808	109.112	153.488
	2	137.800	11.193	112.480	163.120
	3	138.200	10.807	113.752	162.648
	4	132.900	10.268	109.672	156.128

6	1	133.000	9.734	110.980	155.020
	2	129.800	9.285	108.795	150.805
	3	132.500	10.056	109.752	155.248
	4	132.300	9.638	110.497	154.103

Peak power (PP) was reached at different sets for different treatments (PP set 1; **C** *x* = 133.0 SD 9.7, PP set 2; **RA** *x* = 127.7 SD 10.35, PP set 3; **SA** *x* = 134.0 SD 10.7, **PlyoA** *x* = 138.2 SD 10.8, PP set 4; **RAnt** *x* = 133.5 SD 11.6, **SAnt** *x* = 135.6 SD 10.8). Attempting max loads based on the patterns of UB power peaks for each treatment may allow maximal performance to be achieved.

CHAPTER 5

DISCUSSION

The goal of this study was to determine the acute effects of exercise between sets. Paired sets of exercises are widely used in programs implemented by strength and conditioning professionals. Paired exercises allow for increased workloads within a training session and can contribute to greater chronical physical adaptations. Whereas greater benefits in power development can be achieved if peak performance is being achieved acutely within that paired set, overtime maximizing performance. Shifting the focus from quantity to quality of workload relating to UB power. Knowledge of the effects of paired UB exercises is useful for the development of athletes requiring UB power development (e.g. football lineman, field throwers, weightlifters and combat athletes).

None of the treatments in this study had a significant effect on mean UB power when performed between UB power tests, independent of sets. There was no mean difference in UB power across four sets, independent of treatment. Based on the treatment performed and the set, there were significant differences in mean UB power. Differences in mean UB power existed depending on the treatment performed (6 treatments) and tested UB set (4 sets).

There was no significant effect on UB power when performing resistance to agonist (RA) using suspension between sets. A study by Brandenburg JP showed no significant difference in UB power when resistance exercise at different intensities was used prior, concluding that it was a time efficient training strategy that did not affect explosive UB power. (25) Yet, a study by Loudovikos et al. utilized agonist resistance at different intensities of a 1 repetition max (1RM) with two different rest periods prior to a UB power test. The results were significant increases in UB power for 65% 1RM and 4 minutes rest and 85% 1RM at 8 minutes. Therefore the intensity of the prior agonist exercise influences how long a rest period should be when trying to increase subsequent UB power. (24)

The protocol used in this study was intended to be for activation purposes and of moderate difficulty, though it was observed to be challenging to most participants. The angle at which the suspension exercises were performed was controlled, therefore participants were performing a relatively similar percentage of their body weight, serving as the intensity. In the current study no rest between sets was used, the outcome can be found within the neurological, metabolic and non-metabolic factors associated with the demands of the protocol. Neurological activation of agonist groups is based on contractile history. Repeating agonist exercises with a power test successively with no rest would have increased neuromuscular activation and motor unit recruitment. Fast twitch (type IIa, IIx) muscle is associated with power output, depending on the individuals muscle type and fitness level, this protocol may not have initially (sets 1 & 2) recruited fast twitch muscle fibers. Yet the constant demand on the same muscles without rest can result in the recruitment of fast twitch muscle fibers due to the size principle; as intensity increases so does the recruitment of larger motor units (fast twitch) and synergists. This could have caused MUBP to increase from set 1 to 2. However, with greater motor unit activation there can be an associable increase in fatigue. Thus, the balance of an activation exercise and its intensity should be considered. Repeated exercise with no rest to agonist muscle groups also concerns energy systems and their depletion. Phosphocreatine (PCr), the stored energy substrate within muscle is the main contributor of adenosine triphosphate (ATP) or energy through its breakdown catalyzed by creatine kinases for the first eight to ten seconds of exercise. With no time to recover PCr would be depleted. Considering the nature of resistance training, oxygen is insufficient and not readily available. Glycolysis (anaerobic/aerobic) or the breakdown of carbohydrates to produce ATP from glucose in the blood or glycogen (stored glucose in muscle) is the next main contributor of ATP from ~30 to 90 seconds, which would include sets 1 and 2 of the protocol used in the study. Possible individual differences in carbohydrates available could have effected their power output for paired exercises lasting up to 90 seconds. The accumulation of byproducts from anaerobic glycolysis would have elicited the production of hydrogen ions associated with the formation of lactic acid (LA), as pyruvate is converted to LA to further ATP production rapidly. Hydrogen ions make the environment of the muscle cell acidic, disrupting the conditions for actin and myosin binding. This may be shown by the reduction in power after set 2 (~ 90 seconds in). Therefore, ones anaerobic capacity or lactate threshold (percentage of intensity of exercise with ability to buffer metabolites) is a determinate of one's ability to achieve peak performance with paired exercises to agonist muscles groups. Non-metabolic factors such as damage to the muscle tissue itself in the form of cytoskeletal damage and myofibril distortion from exercise performed could too have impacted performance. The combination of a positive effect of increased muscle activation along with negative effects such as increased fatigue and muscle damage could explain the results. Perhaps, muscle activation

(CNS) strategies can be used to counter fatigue caused by substrate depletion in type IIa, IIx fibers by the aid of slow twitch (type I) fiber recruitment. Slow twitch fibers are not primarily used for power exercises, their recruitment can aid in the movement of the exercise itself increasing performance. Another possible countering effect to fatigue with agonist paired sets is the possible removal of metabolic waste. Whereby reducing metabolic waste from accumulating within muscle by promoting blood circulation to active muscles as well as increased ventilation for further removal. Though this is based on the workings of the cardiovascular systems ability to buffer/remove metabolites in blood, anaerobic capacity and the intensity of exercises mentioned earlier. There was no effect on mean UB power for the agonist treatment demonstrating increased workloads, though this treatment had the lowest means compared to the other treatments in the study. Use of these exercises for muscle activation purposes between sets with the intent of increased performance may have a ceiling effect at set 2 or ~90 seconds into exercise. Contributing factors on power output using paired sets could be the result of a combination of CNS activation, muscle types recruited, energy systems and individual differences i.e. fiber type composition and fitness levels represented by anaerobic capacity.

There was no significant effect on UB power when performing stretching to agonist (SA) exercises between sets. Other power studies utilizing light stretching prior to a power test also found no augmentation on performance (10, 15, 16). These studies used shorter durations at lesser intensities.

The mild stretching protocol used in the current study was able to preserve power likely due to the lesser intensity and duration of the stretches, paralleling previous findings. Mild stretches can mainly effect only slow twitch muscle fibers, fast twitch muscles fibers require stretches performed at greater intensities and durations in order to cause a change in length-tension. Power movements are largely produced by fast twitch muscle types, therefore the protocol may not have caused a reduction in power. Tension of muscle cells is a determinate of force production, at decreased lengths there is excessive actin-myosin overlap thus reducing tension. At increased lengths there is minimal overlap thus reducing tension. An optimal length exists between the two that produces the greatest tension and ability for force production. Mechanoreceptors in the form of proprioceptors detect changes in muscle length and tension, they consist of muscle spindles and Golgi tendon organs. The stretch-reflex produced by the muscle spindle has a low threshold. The stretch-reflex is initiated by the CNS when a muscle is stretched or lengthened causing it to contract which increases tension. Possible increases in power across sets 1, 2, and 3 could due to neurological activation of muscle and possible restoration of muscle cells into the optimal length-tension zone. The accumulative effects of acute mild static stretches between sets on range of motion was not measured. Continued use of mild stretches could inhibit the stretch reflex of the nervous system and nerve cells as they become accustomed to lengthening, it is not perceived as a threat to the body. The protocol used does not sustain a stretch long enough to override the stretch-reflex therefore length change is less likely to occur, nor loss in tension. Therefore, mechanoreceptor stimulation from the intensity and duration of the stretch did not cause an inhibitory effect. Furthermore, if mobility is not a limitation in achieving an optimal position to produce a high power output, then not causing a change in length could be beneficial. Optimal length-tensions may restrict the movement of joints from entering into a faulty position of low stability not mechanically sound for producing power. Biomechanically this can increase or conserve power.

There was no significant effect on mean UB power when performing resistance to antagonist (RAnt) using suspension between sets. Similar studies have found contradictory results. Baker et. al. found an increase in UB power output following three ballistic bench pulls with three minutes of rest compared to a control.

UB power improved across all sets for this treatment. It is possible these effects can be attributed to the increase in antagonist activation serving to aid performance in two ways. (A) Increase in movement speed through enhanced joint stability. (B) Reciprocal inhibition results in a relaxation of the opposing muscle group used in the UB power test. This can play a role in the tri-phasic pattern of muscle contraction exemplified by the UB power test. Consisting of a burst from agonist muscles, a braking effect from antagonist muscles, followed by a final clamping effect of agonist muscles. (21) This can be a neural strategy to alter the timing of the braking effect of agonist muscle groups, increasing contraction. (21, 22) Also, a greater net forced produced between agonist and antagonist contractions can be achieved by enhanced synchrony between agonist and antagonist motor units, reducing the effects of co-contraction. These are possible neurological effects of paired sets using RAnt. Though because the intervention was not ballistic the augmentation to the tri-phasic patterns are limited. Furthermore, Snarr & Esco found suspension training achieves greater muscle activation with pulling exercises (23), thus potentially enhancing the effects mentioned above. Also, RAnt using suspension training likely caused activation of agonist muscle groups without directly fatiguing them. RAnt can also be beneficial considering bioenergetics. Where alternating muscle groups between sets allows active recovery to the agonist groups for the following power movement. Proposed benefits include some recovery of the PCr energy system within agonist groups, as this system is the main contributor of energy for short bouts (< 10 seconds) of intense activity. Though the two medicine ball put throws would not deplete this system, additional resistance exercise to these muscle groups between sets would likely deplete this system, likely shown by the effects of RA compared to RAnt. Other considerations for RAnt results can be the accumulated effect of increases in muscle temperature and blood flow to the arms and core across sets, muscle groups utilized in the movements of this study.

There was no significant effect on mean UB power when performing stretching to antagonist (SAnt) exercises between sets. As mentioned above, the stretching protocol was based on previous static stretching studies that found no augmentation in performance. (10, 16)

Short duration static stretching (SS) to antagonist muscle groups can trigger coactivation of these muscle groups by initiating and not overriding the stretch reflex, enhancing joint stability in return improving performance. An unstable joint position can produce limitations mainly by the central nervous system by restricting movement to prevent injury. SAnt can also cause reciprocal innervation to agonist muscle groups and may become more activated. Though activation of muscle groups or joint biomechanics was not analyzed in this study. Additionally, coactivation can alter the triphasic pattern of contraction discussed in a similar manner mentioned above for RAnt treatment. A result of these effects may include decreased resistance to agonist movement. SAnt may also effect the stretch shortening cycle (SSC), though this study used a power test based on concentric explosiveness further investigation on the effect on SSC is needed. Lastly, tight opposing musculature does not allow involved muscles the ability to maximally contract. This treatment may help restore optimal function to the agonist muscles by restoring soft tissue conditions i.e. length and tension to optimal states.

There was no significant effect on mean UB power when performing plyometrics (Plyo) between sets. Plyometric protocol was based on a previous plyometric study that increased lower-body power using 3 reps (4). This study utilized two different types of plyometrics, the more advanced type produced a significant increase in power. Perhaps use of clap push-ups was not the advanced type of UB plyo needed to elicit a positive effect, rather depth box push-ups may be the UB equivalent to double leg box depth jumps to achieve this result.

Plyometrics utilize the stretch-shortening cycle (SSC) of muscle causing greater force output. This is allowed from energy gained from the elastic properties of muscle when stretched and harvested during the immediate contraction that follows. Plyometrics are explosive movements resulting in the recruitment of fast twitch (type IIa, IIx) motor units that are used during high intensity power exercises. Through these systems the greater recruitment of fast twitch motor units can increase subsequent UB power performance through post-activation potentiation (PAP). Whereby increasing the rate of force development and time to peak force, though these mechanisms are influenced by intensity and are shown to be time dependent. (19) PAP causes a phosphorylation of myosin regulatory light chains (RLC) which prime muscles for contractions. (17) This is by caused by an influx of calcium into the sarcomere, awakening the auto-inhibitory segments of the alpha helical myosin head used in modulation of calcium/troponin dependent force generation. (18) The objective remains a balance between potentiation and fatigue when trying to tap into the benefits of Plyo paired sets. The effectiveness of PAP or increased muscle activity depends on the ability to recruit larger fast twitch motor units, though this can elicit fatigue. Three clap push-ups were performed in this study with the objective of increasing neural activity without causing fatigue. Sets one, two and three in this study showed a nonsignificant increase in UB power before a decrease on the final set. Mean peak power was found on the third set. Limited use of clap push-ups or other ballistic UB exercises may be useful for increasing workloads between sets without negatively impacting performance. Maximal pressing exercises/movements (i.e. 1RM bench press) or those for speed (use of bar velocities) may best be attempted on the third set (peak). All other treatments were similar in time (90 secs) between UB power tests except the Plyo treatment, as three clap push-ups were performed quicker (< 6 seconds). Another consideration is the strength-ratio of individuals from pressing exercises to pulling. Rickaby et. al. (20) found greater UB explosiveness in individuals with less strength ratio differences as well as greater pressing strength overall. Strength ratio differences were not measured in this study, only maximal push-ups in a minute which was not a significant covariate. Furthermore, differences in UB strength/power between male and females may have affected the effects of the Plyo treatment between groups. Though reps were held constant, intensity varied based on the participants UB strength/power.

There was no significant effect on mean UB power when provided passive rest (C) between sets. Compared to other treatments excluding RA, passive rest was the least effective treatment across all sets. Moderate stimulation to muscles can provide some type of physiological benefit opposed to passive rest. Though the power test required two maximal efforts, the weight of the medicine ball was likely below 50 percent of a participant's maximal strength. Lighter loads allow for greater forces to be achieved, however this protocol would not have induced fatigue to the extent requiring 90 seconds of rest. Therefore, when using loads less than those associated with strength or power development the recommended sufficient recovery times may not apply, instead a decrease in performance may result. This can be attributed to a possible cool down effect due to no cardiovascular, neurological, and/or psychological stimuli for participants between sets.

CHAPTER 6

PRACTICAL APPLICATION

Light to moderate exercises between sets of large multi-joint exercises may useful for increasing workload without depleting power output. Attempting maximal loads or certain performance objectives (velocities m/s) based on the patterns of UB power peaks for each treatment, may allow for enhanced repetitions or optimal performance to be achieved. This can transform how we approach intensity across sets, depending on the exercise performed between sets. Maximum power capabilities may take place earlier or later across sets, capitalizing on timing this outcome can result in athletes achieving greater performance. Resistance to agonist/antagonist muscle groups between sets can aid further development of those muscle groups due to increased workloads. Mild static stretching exercises can be incorporated between sets as a stimulus to muscles opposed to total passive rest. Plyometric exercise between sets is useful for increasing workload and are effective for training power production. However, plyometric exercise should be used cautiously due to the high impact and stress on the musculoskeletal system when performed.

CHAPTER 7

CONCLUSION

Performing various exercises between sets of an UB power exercise had no effect on performance. Responses in UB power occurred differently according to exercise and set. Opposed to traditional passive rest between sets, it is possible to increase the workload in a given training session by performing exercises between sets without affecting performance across multiple sets. The use of performing exercises i.e. suspension resistance, light stretching, or plyometric between sets can be appropriate between power exercises as acute performance remains.

REFERENCES

(1) Shiraev, Tim and Barclay, Gabriella. "Evidence based exercise: Clinical benefits of high intensity interval training." *Australian Family Physician* (2012) Vol. 41, No. 12, 960-962.

(2) Glenn A. Gaesser, Siddhartha S. Angadi. "High intensity interval training for health and fitness: can less be more?" *Journal of Applied Physiology* (2011) Vol. 111 No**.** 6, 1540-1541 DOI: 10.1152/japplphysiol.01237.2011

(3) Kohn, T. A., Essén-Gustavsson, B. and Myburgh, K. H. "Specific muscle adaptations in type II fibers after high-intensity interval training of well-trained runners*." Scandinavian Journal of Medicine & Science in Sports* (2011) 21: 765–772. doi: 10.1111/j.1600-0838.2010.01136.x

(4) Masamoto, Naoto; Larson, Rich; Gates, Todd; Faigenbaum, Avery. "Acute effects of plyometric exercise on maximum squat performance in male athletes." *The Journal of Strength and Conditioning Research* (2003) Vol. 17 Issue 1, 5-208.

(5) Nicole J. Chimera, Kathleen A. Swanik and Stephen J. Straub. "Effects of plyometric training on muscle-activation strategies and performance in female athletes." *Journal of Athletic Training* Published (2004) Vol. 39(1): 24-31.

(6) Baker, Daniel; Newton, Robert U. "Acute effect on power output of alternating an agonist and antagonist muscle exercise during complex movement." *The Journal of Strength and Conditioning Research* (2005) Vol. 19 Issue 1.

(7) Hoffman, J. R. "Periodized training for the strength/power athlete" *NSCA's Performance Training Journal*. (2002) Vol. 1 No. 9, 8-12

(8) Stone, Michael H., et al. "Maximum strength-power-performance relationships in collegiate throwers." *The Journal of Strength & Conditioning Research* (2003) 17.4, 739-745.

(9) Hoffman, J. R. "Training integration and periodization" *NSCA's Guide to Program Design*. (2012) 215-233

(10) Behm, David A; Chaouachi, Anis. "Review of acute effects of static and dynamic stretching on performance" *European Journal of Applied Physiology*. (2011) Vol. 111 Issue 11, 2633-2651

(11) Snarr, Ronald L. Esco, Michael R. "Electromyographic Comparison of Traditional and Suspension Push-Ups" *Journal Human Kinetics*. 2013 Dec 18; 39: 75–83. Published online

2013 Dec 31. DOR: 10.2478/hukin-2013-0070 PMCID: PMC3916913

(12) Snarr, Ronald L. Esco, Michael R. "Electromyographical comparison of plank variations performed with and without instability devices" *Journal of Strength & Conditioning Research.* 2014 Nov 28; (11):3298-305. doi: 10.1519/JSC.0000000000000521.

(13) "TRX Training/train." *www.TRXtraining.com*. Fitness anywhere LLC, n.d. Web. 11 Nov. 2014.

(14) Sarah M Marek, Joel T Cramer, A. Louise Fincher, Laurie L Massey, Suzanne M Dangelmaier, Sushmita Purkayastha, Kristi A Fitz, and Julie Y Culbertson "Acute Effects of Static and Proprioceptive Neuromuscular Facilitation Stretching on Muscle Strength and Power Output" *Journal of Athletic Training* 2005;40 (2):94–103

(15) Williams, Michael. Harveson, Lanisa. Melton, Jason. Delobel, Ashley & Emilio J. Puentedura "The Acute Effects of Upper Extremity Stretching on Throwing Velocity in Baseball Throwers" *The Journal of sports medicine* 2013; DOI: 10.1155/2013/481490

(16) Shrier, I. "Does stretching improve performance? A systematic and critical review of the literature". *Clinical Journal of Sport Medicine*. 2004 (5):267-73.

(17) Hankcock, Andrew P. Sparks, Kenneth E. & Kullman, Emily L. "Postactivation Potentiation Enhances Swin Performance in Collegiate Swimmers". *The Journal of Strength and Conditioning Research.* 2015 Vol. 29, Issue 4, p 912-917.

(18) Stull, James T. Kamm, Kristine E. & Vandenboom, Rene. "Myosin Light Chain Kinase and the Role of Myosin Light Chain Phosphorylation in Skeletal Muscle". *Arch Biochem Biophys.* 2011. Jun 15; 510(2): 120-128.

(19) Turner, Anthony P. Bellhouse, Sam. Kilduff, Liam P. "Postactivation Potentiation of Sprint Acceleration Performance Using Plyometric Exercise". *The Journal of Strength and Conditioning Research.* Feb 2015. 29(2):343-350.

(20) Rickaby, Daniel. Wright, Glen A. "Agonist- Antagonist Muscle Balance: Effects On Explosive Upper-Body Exercise In Trained Male Athletes". *The Journal of Strength and Conditioning Research.* Jan 2010. Vol. 24 Issue – p 1.

(21) Baker, D and Newton, RU. “Acute effect on power output of alternating an agonist and antagonist muscle exercise during complex training”. *The Journal of Strength and Conditioning Research*. 19: 202–205, 2005.

(22) Robbins, Daniel W; Young, Warren B. Behm, David G. Payne, Warren R. “Agonist-Antagonist Paired Set Resistance Training: A Brief Review”. *The Journal of Strength and Conditioning Research.* Jan. 2010 Vol. 24 – Issue p 1.

(23) Snarr, Ron L. Esco, Michael R. “Comparison of Electromyographic Activity When Performing an Inverted Row With and Without a Suspension Device”. *Journal of Exercise Physiology Online.* Dec. 2013. Vol. 16 (6).

(24) Liossis LD, Forsyth J, Liossis C, Tsolakis C. “The acute effect of upper-body complex training on power output of martial art athletes as measured by the bench press throw exercise.” *Journal of Human Kinetics.* 2013;39:167–175.

(25) Brandenburg JP. “The acute effects of prior dynamic resistance exercise using different loads on subsequent upper-body explosive performance in resistance-trained men.” *Journal of Strength &Conditioning Research.* 2005 May; 19(2):427-32.

APPENDIX

Office
l Review Board for the
›n of Human Subjects

VERSITY OF
BAMA
E A R C H

;, 2015

Anthony Fava
Dept. of Kinesiology
College of Education
Box 870312

Re: IRB#: 15-OR-100-ME "The Acute Effects of Combining Exercises on Performance"

Dear Mr. Fava:

The University of Alabama Institutional Review Board has granted approval for yo proposed research.

Your application has been given expedited approval according to 45 CFR part 46. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies

Your application will expire on April 5, 2016. If your research will continue beyor this date, complete the relevant portions of the IRB Renewal Application. If you wish to modify the application, complete the Modification of an Approved Protoco Form. Changes in this study cannot be initiated without IRB approval, except whe necessary to eliminate apparent immediate hazards to participants. When the study closes, complete the appropriate portions of the IRB Request for Study Closure Form.

Please use reproductions of the IRB approved stamped consent forms to obtain consent from your participants.

Should you need to submit any further correspondence regarding this proposal, please include the above application number.

Good luck with your research.

Carpantab T. Myles, MSM, CIM] CIP
Director & Research Compliance Officer

lministration Building
Box 870127
Alabama 35487-0127
(205) 348-8461
FAX (205) 348-7189
L FREE (877) 820-3066

IRB Project #: 15-(

UNIVERSITY OF ALABAMA
INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS
REQUEST FOR APPROVAL OF RESEARCH INVOLVING HUMAN SUBJECTS

I. Identifying information

	Principal Investigator	Second Investigator	Third Investigator
Names:	Anthony Fava	Phillip Bishop	
Department:	Kinesiology	Kinesiology	
College:	Education	Education	
University:	The Univeristy of Alabama	The Univeristy of Alabama	
Address:			
Telephone:			
FAX:			
E-mail:	Awfava@crimson.ua.edu	Pbishop@bamaed.ua.edu	

Title of Research Project: The acute effects of combining exercises on performance

Date Submitted: 1/25/15
Funding Source: N/A

Type of Proposal	☒ New	☐ Revision	☐ Renewal Please attach a renewal application	☐ Completed	☐ Exem
			Please attach a continuing review of studies form		
		Please enter the original IRB # at the top of the page			

UA faculty or staff member signature: [redacted]

II. NOTIFICATION OF IRB ACTION (to be completed by IRB):
Type of Review: ______ Full board __X__ Expedited

IRB Action:
___ Rejected Date: ________
___ Tabled Pending Revisions Date: ________
___ Approved Pending Revisions Date: ________
___ Approved-this proposal complies with University and federal regulations for the protection of human subjects.

Approval is effective until the following date: 4/5/2016

Items approved:
- X Research protocol (dated ________)
- X Informed consent (dated ________)
- ___ Recruitment materials (dated ________)
- (dated ________)

Approval signature [redacted] Date 4/6/2015