A COMPARISON OF EXERCISE SELECTION MANIPIULATION VERSUS INTENSITY AND LOAD MANIPULATION ON IN-SEASON COLLEGIATE TRACK AND FIELD ATHLETES

By

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Exercise Science to the office of Graduate and Extended Studies of East Stroudsburg University of Pennsylvania

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ABSTRACT

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Title: A Comparison of Exercise Selection Manipulation Versus Intensity and Load Manipulation on In-Season Collegiate Track and Field Athletes

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Abstract

Introduction: The importance of periodization variables in research for athletic populations is drastically overlooked. Proper periodization can allow for maximizing athletic performance as well as reduction of common injuries found in sport. **Purpose**: The purpose of this research is to compare the effects of exercise selection variation versus exercise load and intensity variation on absolute strength and power measures across a 4-week training block for in-season collegiate athletes. **Methods:** 14 Subjects both male and female on a division 2 collegiate track and field team participated in 4 weeks of exercise sessions with two groups being one where exercise load and intensity were used as a variable versus exercise selection being used as a variable of programming. Absolute strength measures were used by measuring a 1RM back squat using the GymAware device and power using a vertical jump, jump mat. **Results:** Results indicate that no significance was found between the change in vertical jump or back squat 1RM from pre-post of either group ($p>.05$). Informal statistics had shown slight improvements in means from the exercise load and intensity group but when numbers were made relative to the subject improvement, the exercise selection group had improved more. **Discussion:** The results lend to the idea that a block greater than 4 weeks may be needed in order to elicit training adaptations favorable to the outcome of one group over the other. In addition, both groups had improved which may also lend to the idea that variation in general is necessary and it does not matter which type of variation. **Conclusion**: In conclusion, no definitive method of introducing variation was found favorable over another in the research.

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CHAPTER 1

INTRODUCTION

Background

Maximizing athletic performance is a multi-faceted process where practitioners must be up to par with the latest methods to do so. In order to achieve this task, research must be incorporated into the practical setting and applied in a manner that allows the practitioner to maximize the athlete's ability to perform. In strength and conditioning, literature and other research lay the groundwork in order to program for athletes of almost any sport or for any competition. Research in this area is important in order to optimize athletic performance and to ensure athletes are getting the best opportunity for growth. One of the biggest issues with strength and conditioning research in regards to programming stems from the conflicting results of various different studies. In a study done by Painter and researchers comparing undulating versus block periodization for track and field athletes had shown that in this instance block styles of training had shown similar statistic strength gains, but had a greater efficiency in providing strength gains when looking at overall load between both programs (Painter et. Al., 2012). Various other studies demonstrate similar results, but yet others exist demonstrating very contrasting results. A second study done by Bartolomei also comparing an undulating style of programming versus a block periodization style of exercise programming had found contrasting results. Results in this study had shown that the undulating style of programming used had actually been more advantageous over block periodization in providing maximal strength measures (Bartolomei, 2015). Although these are two isolated results, a deeper look into research shows similar findings. All different methods of exercise programming have shown supportive results, research also has not given further insight to whether one method of programming may be more advantageous than another.

One of the most popular approaches to programming is periodization. Periodization itself is built around the concept of the General Adaptation Syndrome (GAS) presented by a researcher named Hans Selye. GAS generally states that the body will adapt to a stressor that is presented to it, and thus will undergo favorable adaptation to allow it to overcome this stressor (Selye, 1950). Periodization uses this concept to present systematic “stressors” or in this case systematic variation to cause adaptation. These elicited adaptations should be implemented in a sense that is also favorable to increasing the athlete’s performance. Periodization is constructed in several different forms, whether it be linear or undulating that can allow for variation in training intensity and training volume. Linear periodization is a great start to build upon when considering exercise programming, but falls short in various different stipulations. One of the major components when considering linear periodization is peaking for a major competition. This may be great for a sport where there are one or two major competitions but falls short in sports where there are multiple major competitions throughout the season. A second short-coming of periodization is the vague guidelines on adding exercise variation. Going back to the idea of GAS, variation must be introduced in order to provide a stressor the body can overcome and thus adapt to. The main stressors in which periodization focuses on are exercise intensity, frequency, and load. These stressors are typically introduced and manipulated across cycles of 4-6 weeks to cause adaptation. When exploring the possibilities of variation, one factor that is mentioned but given little to no guidelines or explanations to be implemented is exercise variation in comparison to volume-load. Specific exercise variations have been suggested to drive adaptations within training blocks, but exercise selection has not been isolated as its own individual factor. Even looking at the previously mentioned study done by Painter and researchers, it's seen that within the block periodization group, exercise selection and volume load are both being manipulated. Since both factors are manipulated simultaneously, this also means you cannot infer adaptation from either aforementioned variable. Exercise variation as a sole variable is vastly overlooked and under-researched, but can theoretically provide major performance advantages. A typical goal of the introduction of variation is to avoid a plateau of improvement, and avoid injury. By systematically introducing exercise variation in a timely manner both of these goals can be met while still making progressive gains in strength throughout a workout cycle. In a theoretical exercise program, mesocycle 1 may involve a normal back squat with emphasis on strength. Mesocycle 2 may involve a variation of the back squat such as a pin squat again with an emphasis on strength. Both mesocycles are still working on the athlete's lower body strength, but by manipulating the variation of the focus exercise, the athlete is able to continue to work lower body strength. In this theoretical example, the athlete is able to change muscle recruitment as well as range of motion throughout the exercise as a means of variation. By changing the range of motion being used, the athlete may be able to avoid over-use injury as well. A secondary benefit to exercise variation manipulation is to prepare the athlete for dynamic situations that arise during sport. An athlete will face various ranges of motion throughout a competition, and hence by placing the athlete in different movement patterns in training, they will be better prepared for competition.

In order to investigate exercise variation as a gap in the literature, a primary step would be to compare two exercise programs across 4 weeks in which one has manipulation through exercise intensity and volume but exercise selection is held relatively constant, versus having a second program where exercise and volume are equated to equal to the first group but will in turn have manipulation through exercise selection. In order to equate exercise intensity and volume of each group, the intensities will be added together and averaged from each week of program 1 where the exercise is held constant. The average intensity from program 1 will then be the intensity for program 2 in which the exercise selection is manipulated weekly. Overall workout volume will not be equated due to making the results applicable to a practical setting where workout volume is different amongst different programs. Subjects will be selected from the track and field athletes at East Stroudsburg University and participate in throwing events. To make the research successful, multiple measures of assessment must be utilized through a monitoring program. The focus of the study is on power and maximal strength making the utilization of the GymAware unit necessary, and will provide manageable methods of obtaining both measures of 1-RM strength and force velocity characteristics in one singular test. A secondary measure of power will be the utilization of the Just Jump Mat with the digital timer. First of all, by testing vertical jump, the practitioner can get an efficient and simple measure of explosive power. In addition, measuring vertical jump prior to exercise may give insight to fatigue of the subject. It is known that as an individual becomes fatigued, their vertical jump performance will also decline (Smilios, 1998). If vertical jump assessment is done properly and timely throughout the entire program it may also give an insight to the fatigue the subject experiences prior to initiating each workout. This can be done by comparing the pre-testing vertical jump value to the pre-exercise measure vertical jump value. Vertical jump measures across multiple days can also be compared to see if a specific workout causes more fatigue than another. Gathercole and researchers had previously demonstrated that the utilization of a countermovement jump was not only an efficient method of measuring fatigue, but also repeatable and comparable across multiple days (Gathercole, 2015). By assessing fatigue, the researcher may be able to use this information in order of a measure of prediction of future performance too. In additional to daily measures of power and fatigue, other measures such as a sleep questionnaire, wellness questionnaire, and food and activity logs will be used in order to account for any external factors that may impact performance.

Purpose

To compare the effects of exercise selection variation versus exercise load and intensity variation on absolute strength and power measures across a 4-week training block for in-season collegiate athletes.

Null Hypothesis

There will be no difference between either exercise selection variation groups versus exercise load and intensity variation groups on absolute strength and power measures across the 4-week training block for in-season collegiate athletes.

There will also be no difference between either group in regards to power output measured through vertical jump.

There will be no difference between either group in regards to maximal strength characteristics measured through a 1 repetition maximum back squat.

CHAPTER 2

LITERATURE REVIEW

In the current chapter, existing literature will be reviewed pertaining to the purpose of this study. In order to understand the rationale of comparing intensity versus exercise selection as variables of programming, it is important to first gather background on the process of adaptation and why these factors matter. Adaptation is the process of which an organism gains a new functional capacity from repeat exposure to a stressor. A stressor on the other hand is something that perturbates the organism further from a homeostatic state – causing stress to the system. In the most basic sense, the idea of adaptation from a stressor in relation to human physiology originally stemmed from a researcher named Hans Selye, who coined the process known as the General Adaptation Syndrome or GAS. In Selye's research, it is mentioned that any organism can respond to stress, and overcome this stressor through adapting to it. This process occurs regardless of the stressor that is being presented and may even take place over generations of living organisms in order to evolve to adapt to whatever stressor is consistently present. Selye continues this discussion in stating that the adaptation process occurs through multiple phases. The first phase of which is the "Alarm Reaction" phase, followed by the "Resistance" phase, and finally the "Exhaustion" stage (Selye, 1950). Essentially, the stressor is presented and the body will attempt to resist the stressor in an attempt to maintain equilibrium and in which case adaptation will occur. This process also occurs with exercise and the positive adaptation can vary depending on what mode or variables are present throughout. In the case of this study, two variables to consider as stressors is the variation of the exercise given or the intensity and load of the exercise give.

Looking past the general sense of adaptation, this process can and does occur with exercise. Referring back to GAS, when someone exercises, they are simply exposing themselves to a stressor whether it is external resistance (weight training) or aerobic stresses (endurance training). With weight training, the individual imposes an external resistance to their body which acts as a stressor. By consistently exposing the body to this external resistance, the body will adapt and overcome the stressor presented through adaptation. These adaptations to resistance training are well documented and can take place in the form of both neural and muscular adaptations. Some of the accepted neural changes that are supported through research are motor unit synchronization and rate coding. Synchronization is the ability to recruit a greater number of motor units with a decreased latency period, meaning they can respond quicker to a stimulus by producing force more rapidly. Additionally, after adaptation takes place, these motor units can fire in conjunction with one another. This would infer that with more muscle fibers being active at a given contraction, the force production would also be increased. A study done by Semmler at the University of Colorado Boulder had highlighted some key points regarding motor unit synchronization and neuromuscular performance. In this study, one consistent finding was that multiple supporting evidence has shown following physical activity and even more specifically strength training causes increases in motor unit synchronization (Semmler, 2002). In fact, results showing increases of motor unit synchronization occurring as a product of strength training have been documented for a while now. A second study done in 1975 that had also investigated motor unit synchronization had found that following a 6-week strength training program, motor unit synchronization had also been theorized to have increased (Milner-Brown, 1975). Just as motor unit synchronization is well documented, so is rate coding. Rate coding is the rate at which a neural impulse is conducted to the individual motor units that comprise the muscle. Of course, this is also an adaptation that takes place following resistance training or explosive training such as plyometrics or short sprints. One of the earlier studies done in 1978 by Desmedt and Godaux had looked at the properties contraction rate can play with force production by investigating the discharge patterns of singular motor units. In this study, the researchers compared a voluntary ballistic contraction to a slow ramping voluntary contraction. Contractions were compared in several different fibers from the masseter, soleus, and the first dorsal interosseous muscles. Results had indicated that the force produced during the ramp conditions were actually greater than those produced through ballistic conditions (Desmedt, 1978). Although this doesn't directly lead to the determination of rate coding, it does tell us that the rate at which the muscle contraction takes place does share a correlation to the force being produced. A second study done by Harvard University's medical school had used fibers from a soleus of a cat to demonstrate different muscle fiber characteristics. The researchers had highlighted the relationship of the conduction velocity and maximal force production of the fibers examined. It was found that there is an apparent relationship between the maximum tension of the motor unit and the conduction velocity of its axon. This relationship demonstrated that slowly conducting fibers supplied the smaller motor units where-as the rapidly conducting fibers supplied the larger motor units (McPhedran, 1965). These studies help to highlight the importance that rate coding can make on force production, and show that the rate of the muscular contraction can play a direct role in the force being produced by the muscle.

Keeping in mind that the stressor presented is simply an increased external resistance, these neural adaptations allow for greater force production which eventually leads to overcoming the stress of the external resistance. Aside from the aforementioned neural adaptations, stressing the muscular system can elicit muscular adaptations too. The main muscular adaptation is called muscular hypertrophy. Muscular hypertrophy is the increase of the muscle size through an increase in the muscular cross-sectional area. Muscular hypertrophy has extensive research backing it’s increase in force production capabilities (Goldberg, 1975). Studies across multiple populations of subjects have even found increases in hypertrophy as well as maximal strength following strength training protocols. A study done by researched in 1991 had shown that following a 12-week resistance training protocol for elderly women, muscular cross-sectional area had increased by an average of 20% in type 2 fibers and maximal strength characteristics had increased by an average range of 28-115% in comparison to baseline measures (Charette, 1991). Backed by research of countless studies, it’s evident that muscular hypertrophy is also well documented as an adaptation to strength training.

Although viewing resistance training as a stressor to the organism presents multiple adaptations, there are numerous studies proving endurance training elicits adaptations too. Some of the widely accepted adaptations that can take place through endurance training are an increase in VO2 max, increased mitochondrial density, increased cardiac output through increases in stroke volume, increase left ventricular volume and end diastolic volume, along with multiple other cellular adaptations. Just as with resistance training, taxing the cardiovascular system also presents a stressor to the organism in which the adaptation process can take place. Some studies demonstrate adaptations to cardiovascular training in as little as 10 days. A study done by Mier and other researchers had looked at cardiovascular adaptations following 10 days of a cycle protocol. Throughout the 10 days of the study, subjects had completed multiple cycling training sessions at various intensities correlated to a pre-tested VO2 peak. At the end of the study, the researchers had found that consistent endurance training had caused an increase in plasma volume, and increases in cardiac output and stroke volume during peak exercise (Mier, 1997). Although this study was only 10 days in duration, it still had shown cardiovascular adaptations taking place in such a short duration.

When looking to elicit an adaptation, several over-arching variables become evident. The key variables in any program should be overload, specificity, and variation. It's clear that adaptation takes place in both aerobic and muscular capacities, but how you elicit these adaptations is what becomes key. As the body adapts to the stressor, it becomes necessary to further increase the stress placed upon the system in order to continue adaptation. The principle of overload when referring to training simply means that as the body adapts to the stress placed upon it, it must then be stressed to a greater means than previously done in order to continue positive adaptation. When planning an exercise program, causing stress to the system can be tricky. An exercise program which stresses the system too much may cause exhaustion, and negative adaptation leading to overtraining or burnout. An effective exercise program will allow enough stress for positive adaptation, but not too much stress and thus avoiding exhaustion. Typically, a gradual increase in the load being used in weight training or the intensity of aerobic is a standard means of ensuring overload. This leads into the next variable of exercise programming which is specificity. Specificity is ensuring that the adaptation is going to be advantageous for the desired outcome (Specificity – Science and Practice). A simple example is that if you are aiming to increase strength, it would not be specific nor advantageous to perform endurance training. If you are planning a program to increase strength, focus on the specific variable of strength to cause the desired outcome. A final variable which is key to this study specifically is the idea of variation. Variation in training is simply varying the load or intensity of the exercise being performed. This can be a method of creating overload, but also can be looked at as training for a specific outcome. In a traditional sense, variation when mentioned in research is typically in the form of changing the exercise load or exercise intensity (Zatsiorsky, 2006). Another variable which plays a major role in variation is varying exercise selection. Exercise selection has been mentioned but no major research has been done on whether or whether not it is advantageous or not. Part of the research in this study is to investigate its effectiveness when viewed as a method of variation in compared to traditional methods such as load and intensity.

Overlooking the entire process of adaptation and the factors eliciting them is the planning and implementation of the stressor in order to produce the desired adaptation. A method commonly used to present stressors to create adaptation is a form of programming called periodization. Periodization is the systematic programming of exercise variables in order to create a desired adaptation. These key exercise variables are those just mentioned such as overload, specificity, and variation. Periodization can be done for both aerobic and strength training, but should be tailored around the goals of the athlete or client. For example, a periodization program focusing on increasing muscular strength is going to be drastically different than a program looking to improve endurance. When planning periodization, several methods of combining the key exercise variables mentioned exist. Two of the main styles of periodization are undulating periodization and block periodization. Undulating periodization can take place in several different ways such as weekly or even daily undulations. In undulating periodization, training weeks or training days contain variations of exercise intensity and load and in some cases exercise variation depending on the style. A great example of undulating periodization showing increases in strength output was done by Bartolmei and other researchers in 2015. In this study, weekly undulating periodization was used in which case a 10-week training protocol was used and subjects trained 3 times a week. Results of this study had shown that weekly undulating periodization had shown improvements over block periodization when looking at lower body strength and power measures (Bartolomei, 2015). Although this study had focused on undulating periodization, many other studies focus on another form of periodization called block periodization. In block periodization, training is organized into blocks where a specific focus in placed on the desired outcome. For example, a training block may look like 4-6 weeks of 85% intensity and 4-6 repetitions in a desired exercise to focus on maximal strength as the desired outcome. A second study done comparing block and undulating styles of periodization had contrasting results and had actually shown block periodization to be advantageous over undulating. Painter, Haff, and other researchers at Edith Cowen University had investigated block vs undulating style of periodization. In this study, block periodization group had performed exercises 3x a week for 10 weeks total. This 10-week period consisted of two 4-week blocks as well as one 2-week block at the end prior to post testing. Each block consisted of an individual focus, so block 1 was strength/endurance, block 2 was strength, and block 2 was power. Results had indicated that the block periodization had an advantage over undulating style of periodization in the form of efficiency of strength gains (Painter, 2012). Although both studies show contrasting results in regards to which style of periodization may be more effective, the common ground they share is that their main source of variation throughout the study is a variation in the load and intensity. Neither of these studies, regardless of the form of periodization, focus on varying the exercise selection as a method of variation. An effective method of determining the different exercise selection could make in comparison to load and intensity would be to compare the two variables to determine whether or whether not exercise selection can be a valid factor of variation. Therefore, the purpose of this study is to compare the effects of exercise load and intensity variation versus exercise selection variation on absolute strength and power measures across a 4-week training block for in-season collegiate athletes. An additional question that is pertinent is which method of variation will have a greater impact on performance to the athlete.

CHAPTER 3

METHODOLOGY

In the chapter 3, the methodology of the research will be outlined. The very first step of the methodology was to determine the proper subject pool for the research. The best subjects for the experiment were found to be power and strength-based athletes based on the performance outcomes being measured. The primary performance measures entail testing maximal strength via GymAware Unit which allowed the testing of force velocity characteristics at both the pre and post experiment time as well. Secondary measures included a pre-session vertical jump as well as a pre-session 7 criteria wellness assessment. Both of these measures provided as a secondary measure for power and fatigue across workouts. Subjects were both male and female for the experiment (n=14). In this case, all subjects were college aged male and female division 2 track and field athletes. One of the secondary criteria to be selected is that the athletes primary event had to be power based, this included jumps, throws, and short sprints events. At the start of the study, Group 1 had a total of 3 throwing athletes, 2 multi-event athletes, and 3 sprint-based athletes (group 1; n=8). Group 2 had a total of 3 throwing based athletes, 2 multi-event athletes, and 3 sprint-based athletes (group 2; n=8). Additionally, group 1 had a total of 6 male athletes and 2 female athletes. Group 2 had a total of 5 male athletes and 3 female athletes. At the end of the study, 2 subjects had been dropped from group 2 (both sprint-based athletes) due to un-related injury that had occurred outside of track and field and research related grounds. In addition, all subjects had been exposed to and performed linear periodization prior to the initiation of the current research study.

One of the first procedural steps to the research involved informing the subjects of the risks & rewards of participating in the study. This also included informing the subjects of the methodology and what they will be participating in. Once the subjects were informed of what was proposed, they were asked to fill out an informed consent form, as well as PAR-Q assessments to determine whether or whether not they were fit for physical activity. After the subjects were informed, and the initial precautions are taken, the subjects were randomly selected and randomly assigned to one of two groups. An attempt to balance groups based on gender and event was made in order to equalize groups by splitting gender and track events, and taken a step further by randomly and equally assigning subjects to either group 1 or group 2. Group 1 focused on weekly manipulations of exercise intensity and load with exercise selection held constant i.e. performing back squat for a total of 4 weeks. Group 2 focused on weekly manipulations of exercise selection with exercise intensity and load held constant for a total of 4 weeks. In order to equate for intensities and workloads being different, the average of all of the intensities of group 1 was used as the average for group 2. Exercise intensities were averaged across both groups due to eliminating any extrigent factors. Total load throughout the week was not averaged in order to keep the results applicable to a practical setting. For example, if group 1 has quarter squats as a variation of the back squat, in a practical setting the load will not be reduced to be equated to a normal back squat. The exercise program itself consisted of back squat with manipulations in load and intensity for group 1, and variations of back squat for group 2. Exercises outside of the scope of the study were held constant across both groups. This included total volume at track and field practices, as well as any additional conditioning and weight training was attempted to be made equal within event groups. The exercises were performed 2 days a week with 48 hours rest between exercise days for 4 weeks in duration. The loads and intensities were recorded every session, as well as various other measurements such as the jump mat vertical jump test, and 7-criteria wellness questionnaire. Once assigned to either group 1 or group 2, the subjects then underwent familiarization and pre-testing the week prior to initiation of the 4-week program. On this pre-testing day the subjects performed familiarization trials and 3 vertical jump trials on the jump mat, as well as familiarization and max testing with the back squat using the GymAware Unit to assess max strength and force velocity characteristics. Maximal strength using the GymAware unit was assessed using the two-point method (García-Ramos, 2018). At pre-testing, subjects also were instructed on the usage of the 7-criteria wellness questionnaire. Initiation of the wellness questionnaire started the week prior to the initiation of the exercise protocol in order to get a better assessment of the subject's well-being before the program even started. In week 2, the exercise program began for both groups of the experiment. Subjects from both groups engaged in 3 vertical jump trials where the best number was recorded. This was be done in order to assess fatigue throughout the program. Additionally, this also allowed insight to which day or which exercise variation could have caused the greatest fatigue to the subject. Group 1 started with a normal back squat at the desired percentage and load for week 1. Every week, the intensity and load were manipulated but the exercise remained the same. Group 2 started with the average intensity of all 4 weeks from group 1, but had a different exercise variation i.e. box squat. Every week the variation of the back squat was manipulated in group 2 keeping intensity at the average of group 1's. The desired exercise intensity was manipulated based off the exercise variation for group 2. In addition, the GymAware unit was used in order to make adjustments based off velocity and using Bryan Mann's velocity ranges as a reference for the correct intensity. The actual load was not reduced to match between both groups in order to ensure the practicality of the study. For example, if a quarter squat is being utilized, the load would be far greater than a normal back squat. This would be additional load of the quarter squat would be key in adaptation in a practical setting, so for the purpose of this research the loads were not equated between both groups. Prior to each session, each week the subjects completed and turned in a wellness questionnaire as well as completed their 3 trials of vertical jump. After each session, the subject's load, intensity, repetitions, and any additional notes regarding the exercise performance was taken to get the best assessment. Post 4 weeks of training, 2 sessions per week, 8 total sessions the subjects performed post-testing assessments. During the exercise sessions, 2 subjects had dropped from the study due to unrelated reasons and both subjects were from group 2. On the week following the exercise program, the remaining subjects completed the 7-criteria wellness assessment, as well as the same testing as pre-testing where they performed vertical jump testing on the jump mat, and again GymAware unit was used to detect any changes in force-velocity characteristics and maximal strength for their back squat. All sessions within the study were supervised by a NSCA certified college strength and condition coach in order to ensure proper form, proper load, and completion of the workout and procedures given. Equal encouragement and similar instruction were given across all subjects of both groups. At the completion of data collection, pre-testing was compared to post-testing, and the statistically significant of any reported changes was be analyzed. For formal statistics, a Mann-Whitney U test was used as a measure of nonparametric statistical analysis to account for the uneven distribution of subject numbers across the groups.

CHAPTER 4

RESULTS

Table 1. Weekly Wellness Data

Table 1

Weekly Delta (Group 1 - Group 2)

Category	Total Average
Fatigue	-0.17
General Muscle Strain	-0.07
Pain/Stiffness	-0.16
Power	0.06
Sleep Quality	0.06
Stress	-0.22
Well-Being	0.34

Table 1 shows the change in fatigue compared both groups. A red value indicates that group 1 had a lower value than group 2. Group 1 had scored lower (better) than group 2 on Fatigue, General Muscle, Pain/Stiffness, and Stress. Group 2 had scored better on Power, Sleep Quality, and Well-Being.

Table 2. Delta Vertical Jump

Table 2

Delta Vertical Jump

	Group 1	Group 2
Mean	1.1875	0.6167
Relative Mean	0.1484	0.1028
Overall Mean	1.6625	1.4833
Overall Relative Mean	0.2078	0.2472
	n = 8	*n* = 6

Note. Group 1 = Intensity/Load Variation

Group 2 = Exercise Selection Variation

Table 2 depicts the descriptive characteristics of the change in vertical jump for both groups from pre-post testing. The mean and overall relative mean only include pre and post testing values. Overall values include any trial that had taken place across the entire study. Relative values were the average change in vertical jump equated to the number of subjects in each group.

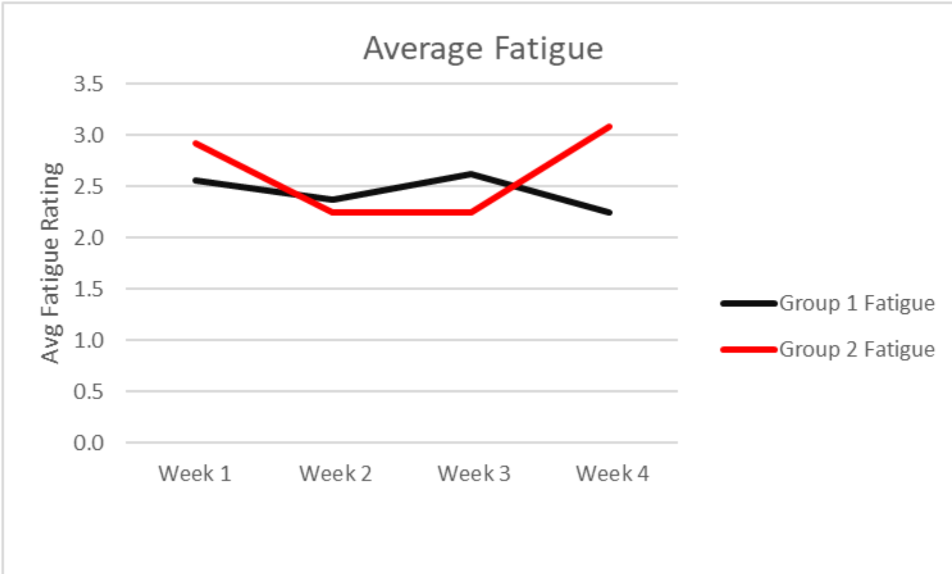


Figure 1. Average Fatigue

Figure 1 depicts a comparison of fatigue between both groups. The illustrated points are the averages across the 4 weeks of the study. The lower the value, the less fatigued the subjects are reporting.

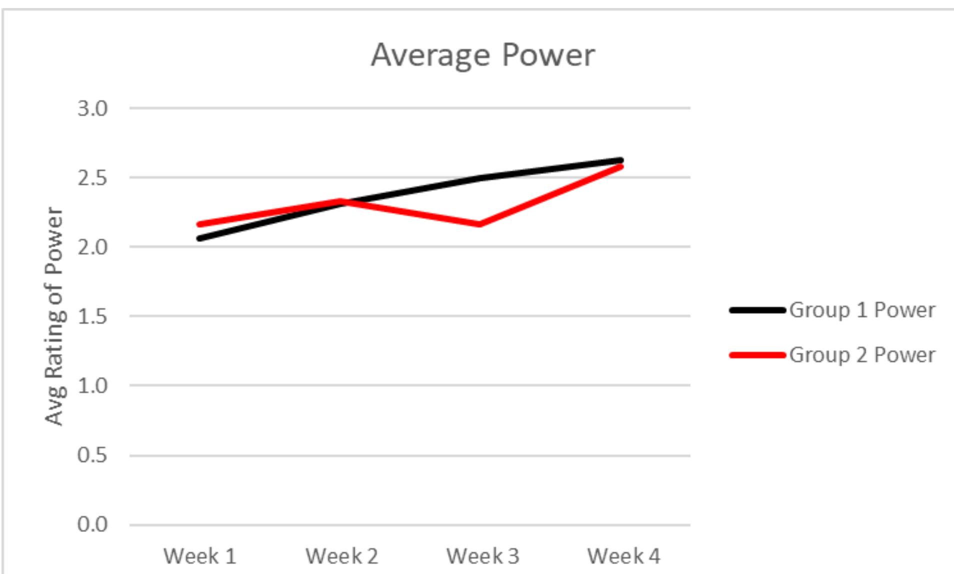


Figure 2. Average Power

Figure 2 depicts the average rating of power between both groups across the 4 weeks. The lower the value means the more powerful the subject is reporting.

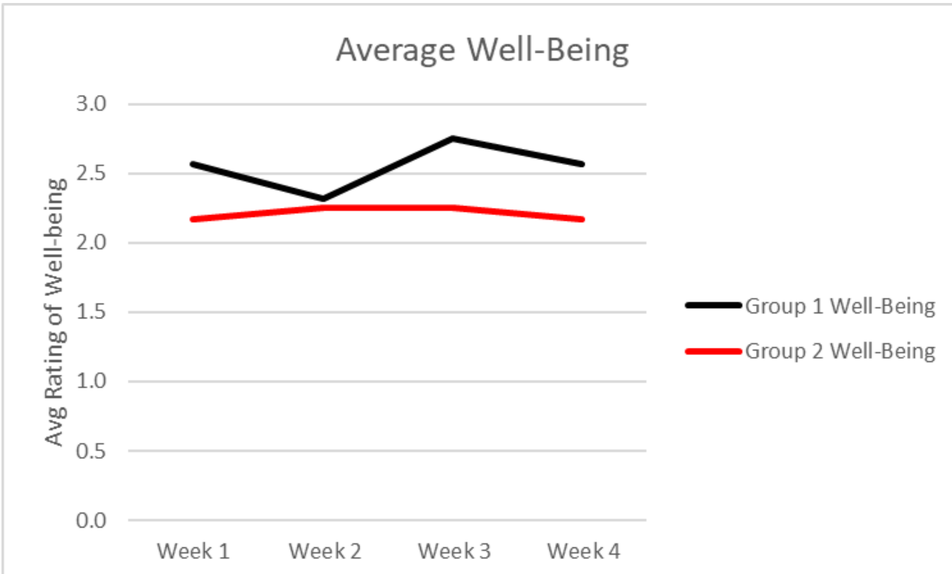


Figure 3. Average Well-Being

Figure 3 depicts a comparison the average rating of well-being across both groups. The lower the value means the better overall the subject is reporting.

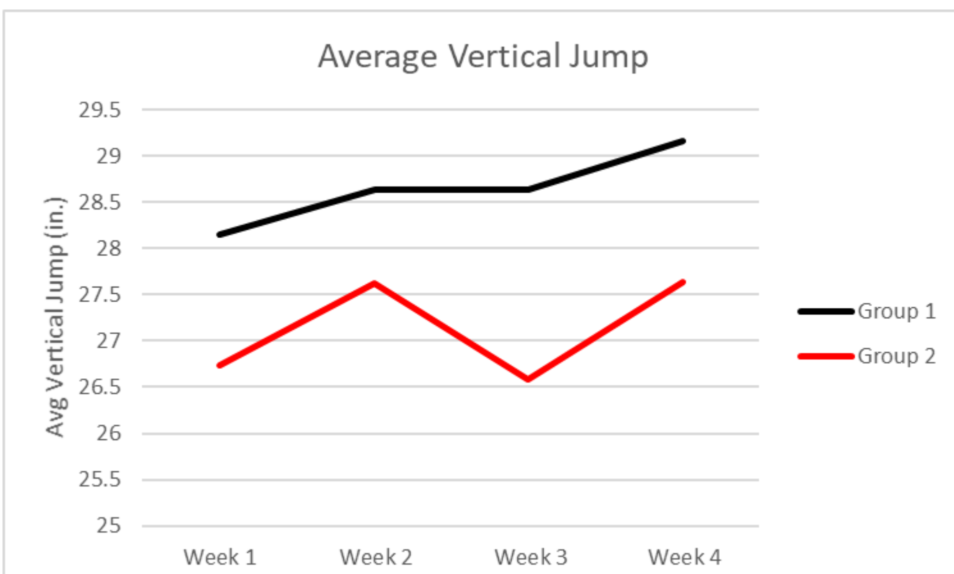


Figure 4. Average Vertical Jump.

Figure 4 depicts the average of all 4 weeks of the vertical jump trials taken from both groups.

Table 3. Delta 1RM Squat

Table 3

Delta 1RM Squat

	Group 1	Group 2
Mean	7.7591	6.7903
Relative Mean	0.9699	1.1317
	n = 8	*n* = 6

Note. Group 1 = Intensity/Load Variation

Group 2 = Exercise Selection Variation

Table 3 includes the change in 1-RM back squat in each group from pre-post testing. Relative values were the average change in 1-RM equated to the number of subjects in each group.

Table 4. Smallest Worthwhile Change

Table 4
Smallest Worthwhile Change

	Standard Deviation	Smallest Worthwhile Change
1-RM (lbs)	84.464	16.8928
Vertical Jump (in.)	4.409	0.8818

Note. 1-RM was performed with the backsquat exercise.

Table 4 includes the standard deviation across all subjects as well as the smallest worthwhile change in all subjects across both 1-RM and Vertical Jump.

Table 5. Pre-Post Data

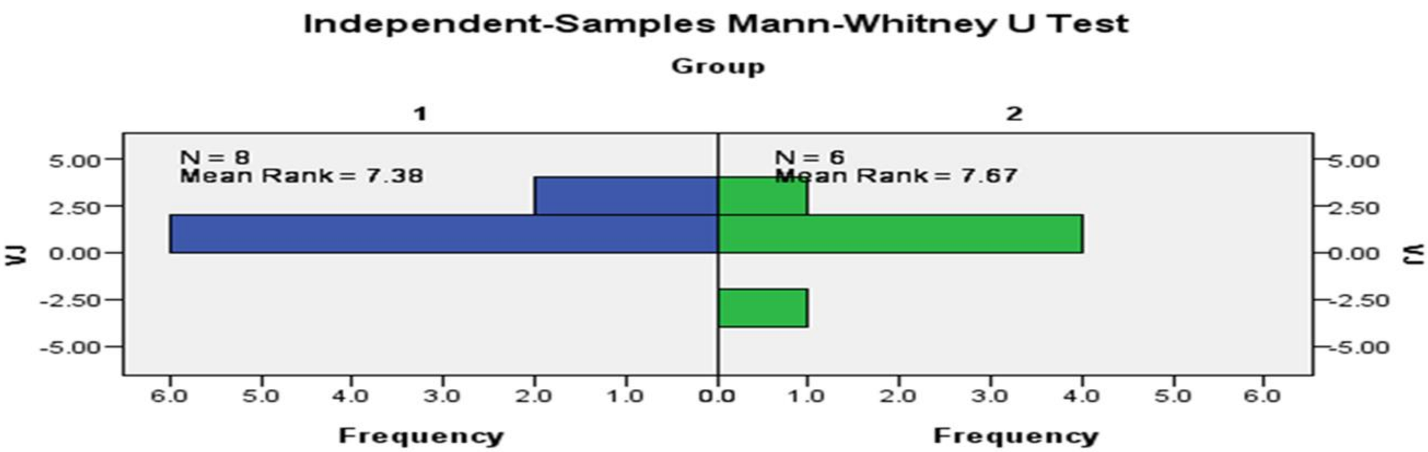
Table 5
Pre-Post Delta

Group 1	VJ	Measured Max	**Group 2**	VJ	Measured Max
Subject 1	0.8	22.0	Subject 9		
Subject 2	0.7	3.0	Subject 10	1.3	15.3
Subject 3	3.6	5.0	Subject 11	0.1	1.5
Subject 4	0.2	-6.1	Subject 12	2.6	21.0
Subject 5	3	15.2	Subject 13	-3.8	-38.7
Subject 6	0.7	20.4	Subject 14	1.7	24.7
Subject 7	0.3	0.3	Subject 15	1.8	17.1
Subject 8	0.2	2.3	Subject 16		
AVERAGE	1.19	7.76	AVERAGE	0.62	6.79
Relatives	0.15	0.97	Relatives	0.10	1.13

*Note. A highlighted value indicates improvement past the smallest worthwhile change. A yellow highlight indicates subject drop-out. A red color font indicates subjects who did not improve or had gotten worse.

Table 5 depicts all of the subject's delta scores from pre-post and illustrates improvement, decrement, and attainment of the smallest worthwhile change.

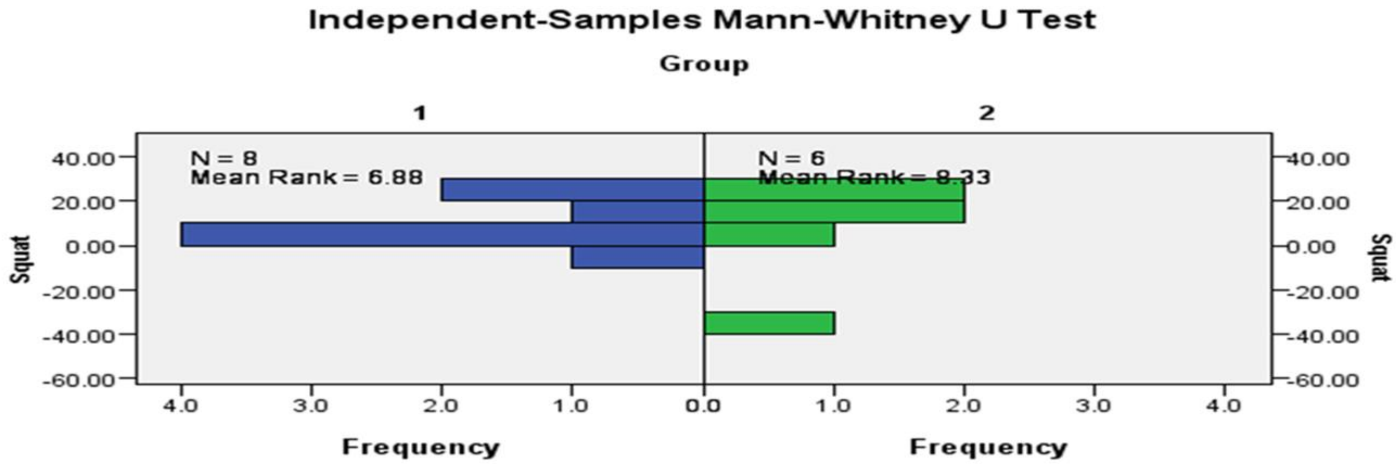
Figure 5. Vertical Jump Independent-Samples Mann-Whitney U Test



Total N	14
Mann-Whitney U	25.000
Wilcoxon W	46.000
Test Statistic	25.000
Standard Error	7.737
Standardized Test Statistic	.129
Asymptotic Sig. (2-sided test)	.897
Exact Sig. (2-sided test)	1.000

Figure 5 demonstrates the spread and significance of the change in vertical jump from pre-post testing for both groups as determined by the Mann Whitney-U test. The result was found to be insignificant with a P value of 1.0 ($p>.05$).

Figure 6. 1RM Back Squat Independent-Samples Mann-Whitney U Test



Total N	14
Mann-Whitney U	29.000
Wilcoxon W	50.000
Test Statistic	29.000
Standard Error	7.746
Standardized Test Statistic	.645
Asymptotic Sig. (2-sided test)	.519
Exact Sig. (2-sided test)	.573

Figure 6 demonstrates the spread and significance of the change in squat from pre-post testing for both groups as determined by the Mann Whitney-U test. The result was found to be insignificant with a P value of .573 (p>.05).

CHAPTER 5

DISCUSSION

In chapter 5, the results will be discussed. Looking at the results, it was found that neither group had presented any statistically significant changes despite looking at both the change in vertical jump and back squat 1RM across both groups. Although no statistical significance was found, looking at the raw data and informal descriptive, some slight advantages were found across groups. In looking at the ratings received from the questionnaire, it appeared that group 1 (Exercise Load Manipulations) had performed better in Fatigue, Pain/Stiffness, General Muscle Strain, and Stress measures. In contrast, group 2 (Exercise Selection Manipulations) had actually performed better in Power, Sleep Quality, and Overall Well-Being. Although group 1 had performed slightly better in more measures than group 2, it could be argued that the measures group 2 performed better in were actually more pertinent to the success of the athlete. Keeping the ratings of wellness in mind, the results had shown interesting findings when looking at the change in vertical jump throughout the study. Comparing Figures 1-4, it’s interesting to note that group 2 appears to have better ratings of overall well-being and power but higher measures in fatigue. This illustrates that although group 2 reported being more fatigued than group 1, they had also reported feeling more powerful and overall better. Comparing the wellness figures to the vertical jump figure, week 3 seems to show that when the athletes reported lower (better) scores in power and fatigue, they had actually experienced a decrement in vertical jump performance. Contrary to what would be expected, feeling more powerful and less fatigued would be expected that a higher average vertical jump would be seen across the subjects of group 2. A final note looking at the tables is simply examining figure 1 showing fatigue. It appears that group 2 has a slightly higher fluctuation of measure of fatigue which can indicate that the alternating exercise selection may be causing additional fatigue in comparison to group 1 who is performing the same exercise and may be exposed to less stimulus. Table 2 depicts the changes in vertical jump throughout the study and also looking at pre-post measures too. When taking the average change in vertical jump for both groups in the pre-post testing, group 1 has a slight advantage with a change of 1.1875 compared to the lesser improvement in group 2 of .6167. Group 1 also had a similar advantage over group 2 when these means were made relative to the subject number. Since subjects performed a vertical jump trial every exercise session, the overall means (all jump trials throughout the study included) and relative overall means were also used in a comparison. When looking at every vertical jump taken throughout the study, group 2 ended up having a slight advantage and had greater improvement than group 1. This may suggest a few things; the first being that the subjects of group 2 accumulated a greater level of fatigue throughout their 4 weeks of workouts and did worse during post testing. The second indication could lead to the idea the 1 + ¼ squat variation performed in the last week may have created excess fatigue for post testing as well. Group 2 also had a singular subject that had performed worse beyond normal measures which can be found in the spread of the Mann-Whitney U figures, and could have also affected the data in the pre-post comparison. This trend may be completely different given a larger subject pool. Looking at the change in squat from pre-post it is found that again group 1 has a slight advantage looking at the mean change. When results were made relative to the subject discrepancy across groups, group 2 actually ends up having a higher advantage per subject in squat improvement when compared to group 1. Interestingly enough, when the measures were made relative and the all of the vertical jump trials across the entire study were used, group 2 had slightly better improvements per subject. When the measures were kept pre-post, and improvements were looked at the group rather than made relative to the subject, group 1 had slightly better improvements. Regardless of improvement, the differences found between groups was very slight and when formal statistics were run, they were also found to be insignificant ($p>.05$). Finally, looking at table 4, the standard deviation of pre-testing measures were taken as well as the smallest worthwhile change was calculated through a 20% of the standard deviation. Using these values, looking at table 5 the total improvement, attainment of the smallest worthwhile change, and even performance decrement for both variables are illustrated. Group 1 had every subject improve in the vertical jump but only 2 out of 8 subjects had attained the smallest worthwhile change. In addition, only 2 out of 8 subjects attained the smallest worthwhile change in the back squat 1-RM measurement as well. In group 1, all subjects had actually improved except subject #4 in the 1-RM. In group 2, 4 subjects of 6 had achieved improvement further than the smallest worthwhile change and all but one subject, subject #13, improved in the vertical jump. In 1-RM measurement, all subjects but subject #13 had improved and 2 out of 6 subjects had improved past the smallest worthwhile change. Looking again at the smallest worthwhile change, it appears that subjects had actually improved slightly more in group 2 than in group 1 when using the smallest change as a threshold of improvement. One subject from group 2 had not improved and had actually post tested worse, which can indicate the subject had been fatigued coming into the post-testing session.

Future Research

An important note is that when looking at other research that involves matters of periodization, it appears research is conducted across around 10-15 weeks in duration (Painter, 2012; Bartolomei, 2015). In addition, these studies looked at 2-3 4-week blocks of training rather than one singular block of training. Research is conducted in this manner due to the time required to acquire a noticeable training adaptation. For future research, it could be vital to incorporate a longer study duration and even increasing each cycle of either intensity/load scheme or exercise selection scheme in order to create a difference between exercise groups. Keeping in mind that improvements still occurred in both groups, and ever so slight differences were also seen in both groups, it could be reasonable to assume that the present differences would also be greater in the study duration was longer as well. Given 8-12 weeks where multiple training blocks could take place could separate the two groups from another and noticeable and significant changes from pre-post could be evident. In addition, following traditional periodization, most mesocycles are typically 2-4 weeks in duration, in which a specific scheme of intensity or modes of exercise are used. Again, this is to allow favorable adaptation, but could also be applied to this current research. A great start would be to allow 2-4 weeks per exercise variation in order to also allow further adaptation.

Limitations

Some potential limitations that were evident in the research had to do with the duration and subject size. In regards to duration, this was briefly mentioned above, but to elaborate further is simply allowing time for adaptation to occur from training. Since this study contained 4 weeks of training, and essentially 1 week per variation of load/intensity or exercise variation this could limit the amount of adaptation that could have taken place. By increasing the duration of study and possible extending the duration of each cycle of variations to closer 2-4 weeks in length, further adaptation could take place and a noticeable and significant trend in the differences between both groups could be more evident.

Although the duration of the study was a potential limitation, the number of subjects was a limitation as well. This research contained 14 subjects, but due to drop outs in group 2, the groups were not equally distributed. This caused the means of the improvements found in the study to favor the group which had the larger subject size. In addition, the smaller subject size per group also had created any outliers to skew the overall data more. For example, in looking at the formal statistics and the spread of the data, one subject had lowered the means and spread of data drastically.

Delimitations

All subjects were required to be on the active division 2 collegiate track and field roster, as well as had to have their primary track and field event be power based in nature. This entailed throwing events, jumping events, short sprints (under 200m), and multi-event athletes that had their primary event being a power event. As groups were randomized, they were also randomly and equally balanced across both gender and event group so an equal number of each gender and event group was found in both of the two groups used in the study. All athletes were supervised by a certified strength and conditioning coach at every testing session, and every exercise session to ensure proper exercise form as well as adequate effort and completion of the program. A 7-criteria wellness questionnaire was performed as well as 3 vertical jump trials at every session in order to assess fatigue and allow for a constant monitoring throughout the study. Finally, two weeks were chosen at random for a nutritional log to ensure the nutrition is relatively similar across both groups as a final measure of attempting to eliminate any confounding variables.

CHAPTER 6

CONCLUSION

In conclusion, although no statistical significance was found between exercise groups both groups continued to improve. Exercise load and intensity variation group had improved with means in every measure over the exercise variation group. Due to the uneven subject distribution, relative measures were completed in which case the exercise variation group had a greater improvement per subject in both power and strength measures in comparison to exercise load and intensity variation group. Looking at improvement using the smallest worthwhile change, group 2 had demonstrated a larger number of subjects improving to this threshold in comparison to group 1 especially in the vertical jump. Further research may lend to increasing the duration of the study as well as increasing the subject size to make any noticeable adaptations more pronounced.

APPENDICES

APPENDIX A IRB FORM

200 Prospect Street
East Stroudsburg, PA
18301-2999

East Stroudsburg University Institutional Review Board
Human Research Review
Protocol # ESU-IRB-052-1819

Date: **March 23, 2019**
To: **Jon Hummel and Gavin Moir**
From: **Shala E. Davis, Ph.D., IRB Chair**
Proposal Title: **"A Comparison of Exercise Selection Manipulation Verses Intensity and Load Manipulation on In-Season Collegiate Track and Field Athletes"**

Review Requested:	Exempted	Expedited **X**	Full Review
Review Approved:	Exempted	Expedited **X**	Full Review

FULL RESEARCH

___ Your full review research proposal has been approved by the University IRB (12 months). Please provide the University IRB a copy of your Final Report at the completion of your research.

___ Your full review research proposal has been approved with recommendations by the University IRB. Please review recommendations provided by the reviewers and **submit necessary documentation for full approval.**

___ Your full review research proposal has not been approved by the University IRB. Please review recommendations provided by the reviewers and resubmit.

EXEMPTED RESEARCH

___ Your exempted review research proposal has been approved by the University IRB (12 months). Please provide the University IRB a copy of your Final Report at the completion of your research.

___ Your exempted review research proposal has been approved with recommendations by the University IRB. Please review recommendations provided by the reviewers and **submit necessary documentation for full approval.**

___ Your exempted review research proposal has not been approved by the University IRB. Please review recommendations provided by the reviewers and resubmit, if appropriate.

EXPEDITED RESEARCH

__X_ Your expedited review research proposal has been approved by the University IRB (12months). Please provide the University IRB a copy of your Final Report at the completion of your research.

___ Your expedited review research proposal has been approved with recommendations by the University IRB. Please review recommendations provided by the reviewers and **submit necessary documentation for full approval.**

___ Your expedited review research proposal has not been approved by the University IRB. Please review recommendations provided by the reviewers and resubmit, if appropriate.

Please revise or submit the following:

APPENDIX B INFORMED CONSENT FORM

Informed consent for scientific study

***Title of investigation**:* A Comparison of Exercise Selection Manipulation Versus Intensity and Load Manipulation on In-Season Collegiate Track and Field Athletes.

***Principle investigator**:* Jonathan Hummel

Overview of study

The desire to maximize athletic performance requires practitioners to be up to date with the latest methods in order to do so. One of the greatest challenges for a practitioner is finding the ideal method of exercise programming that best suites the athletic population that is being trained. The most common approach in exercise programming involves a process called periodization, where stressors are systematically introduced on the athlete in order to create variation in which the body can adapt to and grow stronger from. Current research still relies on these methods by focusing on the introduction of exercise intensity or exercise load variation in order to introduce a stimulus to cause adaptation. As current research falls short in the congruity of its findings, it also neglects guidelines of a vastly under-utilized method of variation such as varying exercise selection.

The current aim of this study is to investigate exercise selection as an additional variable to cause adaptation. Exercise selection in current research is only suggested in terms of specificity, meaning more specific as a workout cycle ensues closer to competition periods. The proposed idea is unique in the idea of examining varying exercise selection versus a group that follows a more traditional route of varying solely exercise intensity and exercise load. Therefore, the purpose of this study is to compare exercise selection manipulation versus intensity and load manipulation on in-season collegiate track and field athletes.

Testing sessions

There will be 10 total sessions during the study and sessions will be performed in the Athletic Weight room In Koehler Field of East Stroudsburg University. The sessions will be as follows:

<u>Session 1: Pre-Testing</u>

Session 1 will take place the first week of the initiation of the study. Participants will be required to perform a standardized warm-up, a vertical jump trial, 1-RM using a linear position transducer, as well as a postural balance assessment. At this period of time, exercise technique will be assessed in addition to testing in order eliminate unnecessary risks of musculoskeletal injury.

Sessions 2-9: Exercise Programming

Following an adequate recovery of at least 3 days minimum, participants will begin exercise programming sessions (2 per week) in their respective experimental groups.

Experimental group 1 will perform the back squat exercise using the current scheme:

- Week 1: Back Squat at 85% | 3 x 5
- Week 2: Back Squat at 87% | 3 x 4
- Week 3: Back Squat at 90% | 3 x 2
- Week 4: Back Squat at 85% | 3 x 5

Experimental Group 2 will perform the average intensity of group 1 (86.75%) but instead perform a variation of the back squat using the current scheme:

- Week 1: Pin Squat at 86.75% | 3 x 4
- Week 2: Box Squat at 86.75% | 3 x 4
- Week 3: Quarter Squat at 86.75% | 3 x 4
- Week 4: 1 ¼ Squat at 86.75% | 3 x 4

Each experimental group will perform a total of 96 working repetitions, at an average intensity of 86.75% with 5 minutes of rest between consecutive working sets. Participants will also be given 3 warm-up sets in order to work up to their desired percentage. A minimum of 3 days between testing and exercise sessions, as well as 48 hours minimum between consecutive exercise session will be given for recovery. Prior to the start of any physical activity for that day, participants will also partake in a subjective monitoring program assessing both physical and psychological factors that may impact performance. Physical measures include fatigue, general muscle, power, pain/stiffness in which participants will rate these measures on a Likert scale of 1-5 (1 being "As good as possible"; 5 being "As bad as possible"). Psychological measures include sleep quality, stress, and well-being following the same 1-5 Likert rating scale. Additional measures of monitoring will include a randomly selected food log for a week for both groups, as well as activity logs for the day. Before exercise programming commences, both groups will go through a standardized warm-up, at the end of the warm-up, participants will go through 3 measured vertical jump trials in which the best trial will be taken. This will allow for a secondary measure of the subject's fatigue by comparing vertical jump heights across days.

Session 10: Post-Testing

Post-testing procedures will be held as similar to pre-testing as allowable. Participants will be required to perform a standardized warm-up, a vertical jump trial, and a 1-RM using a linear position transducer.

As a measure of precaution, the standardized warm-up, exercise technique assessment at pre-testing, & subjective monitoring program will be used in order to reduce the likelihood of musculoskeletal injury. In addition, spotters will be used during the back squat exercise to ensure the participants safety at all sessions.

Although you will be undergoing physical testing, there is very little risk if you are a normal healthy individual. Individual information obtained from this study will remain confidential. Non-identifiable data will be used for scientific presentations and publications and you may withdraw from the study at any time. If you have any questions please ask Jonathan Hummel before signing this consent form.

If you have any additional questions during or after the study, Jonathan Hummel can be contacted at:

jhummel9@live.esu Tel: (717) 348-8373

YOU ARE MAKING A DECISION WHETHER OR NOT TO PARTICIPATE. YOUR SIGNITURE INDICATES THAT YOU HAVE READ THE INFORMATION PROVIDED AND YOU HAVE DECIDED TO PARTICIPATE IN THE STUDY.

I have read and understood the above explanation of the purpose and procedures for this study and agree to participate. I also understand that I am free to withdraw my consent at any time.

____

Print name

______________________ ______________________ _______________

Signature Witness signature Date

APPENDIX C PAR-Q+ FORM

2019 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	YES	NO
1) Has your doctor ever said that you have a heart condition ☐ OR high blood pressure ☐?	☐	☐
2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity?	☐	☐
3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? **PLEASE LIST CONDITION(S) HERE:** ______	☐	☐
5) Are you currently taking prescribed medications for a chronic medical condition? **PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:** ______	☐	☐
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer **NO** if you had a problem in the past, but it **does not limit your current ability** to be physically active. **PLEASE LIST CONDITION(S) HERE:** ______	☐	☐
7) Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity.
Please sign the PARTICIPANT DECLARATION. You do not need to complete Pages 2 and 3.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow International Physical Activity Guidelines for your age (www.who.int/dietphysicalactivity/en/).
- You may take part in a health and fitness appraisal.
- If you are over the age of 45 yr and NOT accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.
- If you have any further questions, contact a qualified exercise professional.

PARTICIPANT DECLARATION

If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that the community/fitness center may retain a copy of this form for its records. In these instances, it will maintain the confidentiality of the same, complying with applicable law.

NAME ______________________ DATE ______________

SIGNATURE ______________________ WITNESS ______________

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER ______________________

If you answered YES to one or more of the questions above, COMPLETE PAGES 2 AND 3.

Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ at **www.eparmedx.com** before becoming more physically active.
- Your health changes - answer the questions on Pages 2 and 3 of this document and/or talk to your doctor or a qualified exercise professional before continuing with any physical activity program.

APPENDIX D 7-CRITERIA WELLNESS QUESTIONNAIRE

PHYSICAL MEASURES

How would you rate your current level of fatigue?

1 2 3 4 5

How would you rate your current general muscle strain?

1 2 3 4 5

How would you rate your current pain/stiffness?

1 2 3 4 5

How would you rate your current power?

1 2 3 4 5

PSYCHOLOGICAL MEASURES

How would you rate your current sleep quality?

1 2 3 4 5

How would you rate your current level of stress?

1 2 3 4 5

How would you rate your current level of overall well-being?

1 2 3 4 5

Note: 1 = Feeling as good as possible

5 = Feeling as bad as possible

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