HIGH SCHOOL COACHES'KNOWLEDGE OF PLYOMETRIC EXERCISE

A THESIS

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by
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THESIS APPROVAL

Graduate Athletic Training Education

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INTRODUCTION

Plyometric exercises are one technique used by athletes to increase maximal power output and jumping ability in sports. Plyometric training is an established technique for enhancing athletic performance but may also facilitate beneficial adaptations in the sensorimotor system that enhances dynamic restraint mechanisms and corrects faulty jumping or cutting mechanics, thus reducing the chance for lower extremity injury such as Anterior Cruciate Ligament tears.[1]

One of the primary training goals of plyometric exercises is to increase maximal power output and jumping ability.[2-4] Using plyometric training in a safe and correct manner has been shown to produce many positive results such as increased jump height, development of muscle power, and increase muscular endurance.[1,2]

Coaches may be aware of plyometrics and how they can be used to help benefit athletes, but may not know how to perform them safely and implement them effectively into their team workouts. There are multiple training programs that are readily available to high school coaches, but an

exhaustive search of the literature examining the extent at which coaches use plyometrics effectively and safely when training their athletes is still widely unknown.[2]

Plyometric training is based on the Stretch Shortening Cycle.(SSC) When muscles undergo rapid eccentric elongation just before rapid concentric contraction it is known as the stretch-shortening cycle (SSC).[5,6] The muscle is essentially stretched while loaded, resulting in greater force generated during a subsequent concentric contraction from a static position[2]. The rapid change in contraction allows for better performance such as increased vertical jump height and power output. If a muscle has the ability to adapt to the SSC it enables the individual performing the action to generate greater power.[6] The Stretch-Shortening Cycle is important to athletes because generating a greater amount of power can have positive effects on athletic performance such has increased vertical jump and faster sprint speed.

For coaches to effectively implement plyometric training with their athletes they must address several important training factors. Two major factors in determining the success of a plyometic training program is progression and recovery.[7] A few common signs that an individual may not be ready to progress within their program are: 1).If the athlete shows extensive bending at

the waist or their torso produces excessive forward flexion or lateral bending, more core work may be needed; and 2). If the athlete exhibits prolonged contact with the floor, they may not have the overall body strength and power necessary to proceed.[3] If the athlete's knees are collapsing towards each other producing genu valgus, this may mean lack of quadriceps strength. This can occur on landing during the eccentric contraction or on push-off of the concentric phase. If the level of exercise is not decreased, these movements can lead to joint pain, tendinopathies, excessive muscle fatigue of the legs, and a decreased demonstrated ability to explode. Without allowing for proper recovery, fatigued muscles will cause the athlete to have poor and improper exercise techniques which may lead to injury. It is crucial an individual's techniques are performed properly to avoid injury. Additionally, it is crucial that recovery time is adequate, otherwise the athlete may become susceptible to overtraining.[8] In a recent study performed by Luebbers and Potteiger, the importance of a recovery period following a plyometric program was examined. The study showed when participants were allowed four weeks to recover, that period of recovery had a powerful effect upon performance. It is unclear if the results would have increased more with

a longer recovery, but it is clear that a recovery period should be included following a plyometric training program to achieve maximum results.[6]

Intensity also plays a crucial role in plyometric exercise. In plyometrics, the intensity of a training session is determined by the exercises that are being performed or the rate of the SSC. Plyometric exercises can range from within a wide variety of intensities. Exercises such as core twists would be fairly low in intensity while box depth jump exercises would be very high in intensity. Lastly, volume is a vital piece of information crucial to a successful plyometric program.[11]

Volume in plyometric exercises is determined by the number of foot touches within a training period. Foot touches may vary due to participant's age, gender, or experience. Volume measured in foot touches is inversely related to training intensity. The more foot touches per workout, the lower the intensity should be and the less foot touches per workout, the higher intensity. Therefore, low intensity programs will consist of about 400 foot touches per workout while high intensity workouts consist of anywhere from 250- to 300 foot touches.[12]

Plyometric exercise has been proven to increase muscle output, power, endurance, and vertical jump height

as well as decrease the risk of injury.[1-4] The purpose of this study is to examine high school coaches' level of knowledge of plyometric training. Plyometric training that is done incorrectly can result in injury and/or have negative effects on performance.

METHODS

The purpose of this study was to determine high school coaches' knowledge of plyometric exercise. This section includes the following subsections: Research Design, Subjects, Preliminary Research, Instruments, Procedures, Hypotheses, and Data Analysis.

Research Design

A descriptive design was used in this study with data collected via a web based survey. The primary purpose of this study was to examine the knowledge of plyometric exercise amongst high school coaches. The dependent variable of this study was coaches' knowledge of plyometric exercise. The independent variables of this study include: the coaches gender, the gender of the sport they coached, and their age.

A strength of this study is content validity was established for the survey after a review by a panel of experts. Limitations of this study are only high school coaches in Pennsylvania were survey, the survey cannot be distributed directly to high school coaches in the

Pennsylvania Interscholastic Athletic Association (PIAA), and the survey was not generalized to the entire population of coaches in the United States.

Subjects

Subjects in this study were composed of high school coaches in the Pennsylvania Interscholastic Athletic Association (PIAA) throughout the state of Pennsylvania.

Preliminary Research

Prior to distribution of the survey to subjects, the survey was completed by 6 coaches at the collegiate level to determine reliability. A Pearson Product moment correlation was performed to determine correlation coefficients for each question as well as the survey as a whole.

Instruments

The Knowledge of Plyometric Training Survey (Appendix C4) was used in this study. The survey was developed by the researcher to determine knowledge of plyometric training

amongst high school coaches. The survey consists of ten demographic questions and twenty questions pertaining specifically to plyometric training. These questions were based on published literature on plyometrics.

Procedures

Approval from California University of Pennsylvania's Institutional Review Board for Protection of Human Subjects form (Appendix C2) was obtained prior to data collection. The survey was read for content and faced validity by a group of experts in the field of athletic training. The following procedure was followed to distribute:

1. An email containing a cover letter explaining the study with a link to the survey was emailed to the executive director of the PIAA.
2. The executive director forwarded the cover letter and link to surveymonkey™ to all athletic directors within the PIAA.
3. Athletic directors then forwarded the email to their respective high school coaches.
4. High school coaches had 4 weeks to complete the online survey.

5. Reminder emails were sent at week 2 to remind the coaches to complete the survey.

Once the data collection was complete, the researcher downloaded the data to SPSS 18.0 for data analysis.

Hypotheses

The following hypotheses are based upon previous research after a review of the literature.

1. There will be no significant difference in plyometric knowledge test scores between coaches of different gender at the high school level.
2. There will be no significant difference in plyometric knowledge test scores between coaches of female versus male sports at the high school level.
3. There will be no significant difference in plyometric knowledge test scores between coaches based on number of years coaching.

Data Analysis

The first two hypotheses were measured using a one-way T- Test while the second two hypotheses were tested through

the use of ANOVA. For all hypotheses alpha was set at a $p < .05$.

RESULTS

The purpose of this study was to determine Pennsylvania high school coaches' knowledge of plyometic exercise. Data was collected via an online survey using Surveymonkey™ and was accessible for four weeks for all coaches within the Pennsylvania Interscholastic Athletic Association (PIAA). This section has been divided into the following sections: reliability testing, demographics and hypothesis testing.

Validity

The High School Coaches' Knowledge of Plyometric Exercise survey was reviewed for face and content validity by a group of experts from University of Maine at Presque Isle and California University of Pennsylvania.

Reliability testing

The High School Coaches' Knowledge of Plyometric Exercise survey was created by the researcher based on previous surveys and literature pertaining to plyometric

exercise. Reliability of the survey instrument was obtained through the use of six collegiate coaches at California University of Pennsylvania. The survey was administered twice and received equal responses after the second administration 2 weeks later. The Data was consistent when analyzed by the researcher and deemed reliable. With a Pearson Product moment correlation coefficient ($r(6)=.984$, $p<0.05$), indicated a significant linear relationship between the two tests and a strong positive correlation. This is shown in table 1 below.

Table 1. Initial and follow up test scores

Source		**Pre**	**Post**
Initial	Person Correlation	1	.984*
	Sig. (2-tailed)	1	.000
	N	6	6
Follow up	Person Correlation	.984*	1
	Sig. (2-tailed)	.000	
	N	6	6

**Correlation is significant at the 0.05 level (2-tailed)

A Cronbach's Alpha scale was also used to test reliability for this survey. A score of .670 was found.

Demographic Data

The director of the PIAA forwarded a link of the survey to all coaches in the PIAA. Total number of surveys sent was unattainable due to third party distribution. One hundered fourty-nine coaches logged onto survey monkey and submitted a survey, however, due to incomplete data, 82 surveys were used for the first hypothesis, 78 surveys were used for the second hypothesis and 88 surveys were useable for the third hypothesis.

Hypothesis Testing

The first two hypotheses were measured using a one-way T- Test while the second two hypotheses were tested through the use of ANOVA. For all hypotheses alpha was set at a $p < .05$.

Hypothesis 1. There will be no significant difference in plyometric knowledge test scores between coaches gender at the high school level.

Conclusion: An independent-samples *t* test was calculated comparing the mean score of participants who identified themselves as male (n=62) to the mean score of participants

who identified themselves as female (n=20). No significant difference was found. The difference between the mean score of the male group (m=6.76, sd=±3.486) was not statistically significant from the mean of the female group (m=6.75, sd=±2.403, p=.188 p<0.05). Table 2 shows the mean scores between coaches gender.

Table 2. Mean scores between coaches gender

Gender	**N**	**Mean**	**Std. Deviation**	**P-Value**
Male	62	6.67	3.486	.188
Female	20	6.75	2.403	

Hypothesis 2. There will be no significant difference in plyometric knowledge test scores between coaches of female versus male sports at the high school level.

Conclusion: An independent samples *t*-test was calculated to test significance of hypothesis 2. The difference of the mean score of the male sport (coaches) compared to the female sport (coaches) was found to not be statistically significant. (Males= 6.98, sd ±3.984, Females=6.65, sd ±2.791,p=.170). This is displayed below in table 3.

Table 3. Knowledge scores between male sports vs. female sports

Sport	N	Mean	Std. Deviation	P-Value
Male Sport	41	6.98	3.684	.170
Female Sport	37	6.65	2.7191	

Hypothesis 3. There will be no significant difference in plyometric knowledge test scores between coaches based on the coaches' age.

Conclusion: The coaches' ages ranged between 18-60 years (or older.) Scores in different age groups did not show significant differences as shown in table 4. Additionally, age group distribution is shown below in Table 5.

Table 4. Plyometric scores between different age groups

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	8.924	5	1.785	.162	.976
Within Groups	904.519	82	11.031		
Total	913.443	87			

Table 5. Significance between coaches' age groups

Age Group	N	Mean	Std. Deviation	Std. Error
2. 18-20 yr. old	1	8.00		
3. 20-29 yr. old	16	6.88	3.181	.795
4. 30-39 yr. old	29	6.62	3.133	.582
5. 40-49 yr. old	20	6.30	3.771	.843
6. 50-59 yr. old	17	7.06	3.363	.816
7. 60-above yr. old	5	6.20	2.588	1.158
Total	88	6.67	3.240	.345

DISCUSSION

In discussion of the findings of this study, the following sections are presented: (1) Discussion of Results,(2) Conclusions, and (3) Recommendations for Future Research.

Discussion of Results

This study was conducted to investigate Pennsylvania high school coaches' knowledge of plyometric exercise. One of the primary training goals of plyometric exercise is to increase maximal power output and jumping ability, which when used in a safe and correct manner has been shown to produce positive results such as increased jump height, development of muscle power, and increase muscular endurance.[1,2-4] Additionally, plyometric exercise has been shown to potentially decrease lower extremity injuries when implemented in a safe and effective manner[1-4] Although coaches may be aware of what plyometric exercises are, their knowledge of how to perform plyometrics in a safe and beneficial manner are still widely unknown.[2]

The results of this study found there were no significant knowledge score differences between male and female coaches or the gender of which they coached. As previously mentioned, plyometrics have been used effectively to decrease lower extremity injuries, particularly in female athletes[1-4].

A study performed by Mandelbaum et al.[17] looked to determine whether a neuromuscular and proprioceptive performance program was effective in decreasing the incidence of ACL injuries in young female athletes. The athletes were asked to perform a sport specific training intervention in the trial. The intervention consisted of education, stretching, strengthening, plyometrics, and sport specific agility drills. The study consisted of a female sport training group and a control group made up of girls of the same age group in the same league. Results concluded that during the season, there was an 88% decrease in ACL injuries in the enrolled subjects compared to the control group. In the next season there was also a 74% reduction of this same injury.

The conclusion from this study was that using a training program such as plyometrics could have a direct benefit in decreasing the number of ACL injuries in females.[17] This would lead one to believe female coaches as

well coaches of female athletes would have a particular interest in implementing plyometrics into their programs. Sports that involve explosive jumping, cutting, and sprinting are more likely to use plyometric exercise to increase vertical jump height and power, such as basketball.[2-5] Additionally it was hypothesized there would be no significant difference in scores between coaches of female verses male sports at the high school level. The theory behind this hypothesis is that coaches of female sports would recognize the significant differences in lower extremity injury rate amongst their female athletes compared to male's injury rate of ACL tears.[2-5]

Lastly, we hypothesized there would be no significant difference in plyometric knowledge test scores between coaches age groups. Because plyometric training is a relatively new technique, the researcher believed that the younger coaches would be more knowledgeable with this type of training due to the fact that it may have been a technique they performed as younger athletes. Coaches that were older in the age groups may have been "set in their ways" of training and have not adapted the more recent techniques like plyometric exercise, thus leading to lower scores. However, results showed that all age groups scored very similarly in this study.

Recently, mild traumatic brain injury or concussion, has received an enormous amount of attention in both the medical world and media. Research has also been conducted, similar to ours, investigating coaches' knowledge of concussion prevention, recognition and treatment.[14] Studies investigating concussion awareness and coaches have shown recent knowledge improvement over the last decade.[14-15]. This may be attributed to recent campaigns to increase coaches knowledge of the recognition and treatment of concussions which has shown to produce positive results when working with athletes who have suffered a brain injury.[14]

In a study by Guilmette et al., coaches' knowledge of concussions was surveyed.[14] After the baseline test, coaches were given a review of *Heads Up*, educational materials focusing on concussion and coach recognition. Seventy percent of coaches who had received and reviewed the material reported the information provided to be very helpful. Included in the material was information on educating coaches about all aspects of a concussion injury. When asked about how the coaches planned to use the materials, a significant majority reported they planned to give it to athletes and parents. Overall, the study concluded that coaches seemed eager and willing to learn

more about concussions if the material were made available to them.[14]

Another recent study by Sawyer et al. evaluated coaches' perceptions, assessment, and use of a "toolkit" that was sent to high school coaches on how to prevent and manage concussions among high school athletes. The kit included a facts sheet, posters and a video. Upon telephone follow up, most coaches reported that they had used or planned to use the kit materials with their athletes. Eighty-one percent of schools with a written plan for preventing and managing concussions said that the toolkit could be used to improve their current plan and 96% of coaches who did not have a plan indicated that the kit could be used to develop one. Coaches agreed that a visually appealing kit that was easy to understand would be beneficial to their teams. To conclude, this study provided confirmation that the toolkit should be viewed as appealing and useful material for high school coaches and is likely to contribute to increased prevention and improved management of concussions amongst high school athletes.[15]

The previous studies show that coaches are willing to implement changes if given the right materials. If coaches are receptive to informative videos, posters, or handouts

on concussions, perhaps the same educational techniques could be used for those coaches who wish to incorporate plyometric exercise into their workouts.

Conclusion

The findings of this research provide some insight of high school coach's knowledge of plyometric exercise in the state of Pennsylvania. Although none of the hypotheses were found to be significant, it is worth noting the average scores of the survey were very low with mean scores of 6 correct, well below 50% correct for the survey. I believe this may have occurred in part due to complexity of as well as the concepts involved with understanding plyometrics. Without correct knowledge of volume, intensity, rest time, periodization, and proper technique it is very difficult to understand the principals of plyometric training. A firm understanding of biomechanics, exercise physiology, and strength training is needed to incorporate plyometrics in a safe and effective manner. Often times coaches have not had experience or education with plyometrics and this may lead to improper training programs and an increased risk of injury. If coaches wish to implement plyometric training, I

think that is important for them to first have the correct knowledge of plyometric exercise.

Recommendations for Future Research

The research study, Coaches Knowledge of Plyometric Exercise has investigated a limited population of coaches within the state of Pennsylvania. The results of the study have yielded a few primary recommendations by the researcher for future research on this subject.

The survey should be distributed more efficiently, specifically, by the researcher themselves, instead of relying on a third party. Ensuring the survey and researcher is more easily accessible to coaches may increase the rate of return.

The second recommendation is to focus on high school coaches that do currently implement plyometric exercise in their programs rather than coaches who may or may not use them. If coaches who use plyometrics are the only ones to respond, it may be able possible to get a clearer assessment of their knowledge of plyometric exercise and how they implement them at their high school setting.

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APPENDICES

APPENDIX A

Review of Literature

REVIEW OF THE LITERATURE

Plyometric exercise at the high school level is becoming a popular training technique used by high school coaches. Plyometric exercises are used primarily to increase maximal power output and jumping ability. Plyometric training is an established technique for enhancing athletic performance but may also facilitate beneficial adaptations in the sensorimotor system that enhance dynamic restraint mechanisms and correct faulty jumping or cutting mechanics.[1]

Ploymetric training has been shown to increase vertical jump performance. Vertical jumping is affected by muscular and neural aspects alike. In order for a subject to jump higher, the greatest amount of vertical acceleration needs to be achieved before leaving the ground. The acceleration creates initial vertical velocity. The greater the velocity, the higher the center of mass will reach. In order to achieve the greatest vertical acceleration, the individual needs to create as much force as possible over the shortest amount of time. It is crucial that by increasing muscle mass and by training neural mechanisms alike, an athlete can jump higher and react faster.[2] Some other advantages of plyometric training is it

increases functional power and allows the muscles to reach a higher power level. Plyometric training has also been shown to decrease muscle reflex inhibition, increases the sensitivity of the Golgi tendon organs, improve the sensitivity of the muscle spindles, and increases muscle tension while reducing risk of injury.[3-8] These may all in turn, increase performance while also decreasing the risk of injury.

This review of the literature aims to explain plyometric exercise and its scientific benefits as well as high school coach's knowledge of plyometric training including the knowledge of risks, benefits, routine schedule, and sources of information. The information will be broken into the following sections: defining plyometric training, plyometric training effects on the lower extremity, effects of various types of plyometric programs, and high school coach's knowledge of plyometric exercise.

Plyometric Training

Plyometric exercise is defined as eccentric loading immediately followed by a concentric contraction.[9] Research has shown that the main goal of plyometric training is to increase maximal power output and also increase vertical

jump height. This can be achieved thru exercises that include bounding, hopping, and other jumping exercises with one or two legs.[10-11] In order to understand how plyometric exercises work, one must first understand basic muscle physiology and the actions that the muscles will perform during plyometric exercise.

Muscles have the ability to both passively lengthen and contract. Having the ability to lengthen and contract allows us to perform dynamic movements of the body. Each muscle fiber contains thousands of smaller rodlike strands referred to as myofibrils. Myofibrils are contractile structures made of myofilaments. The myofibrils lie parallel to the long axis of the muscle cell and extend the length of the muscle. The myofibrils function to contract, elongate, or relax a muscle.[1]

Also involved in the contraction of muscle are Golgi tendon organs (GTOs). The GTOs are located in the muscle-tendon junctions and in the tendons at both ends of the muscles. These receptors are stimulated by tension in the muscle-tendon unit. GTOs detect tension in the muscle and cause the muscle to act upon the change of tension by contracting or lengthening. Both myofibrils and GTOs play an important role in contraction during plyometric exercise. When the muscle is contracted or lengthened

during jumping, the GTO's detect the change of length in the muscle and quickly act upon that change.[1]

Muscle contractions are the basis for all human movement, and our muscles have 4 characteristics that allow a muscle to produce movement. These 4 characteristics include irritability, contractility, extensibility and elasticity. Irritability refers to the ability of a muscle to receive and respond to stimuli via chemical message from a neurotransmitter, and then in turn, respond with an electrical current to produce movement. Contractility is the ability of a muscle to shorten when responding to stimuli. Contractility allows a muscle to produce force. Elasticity is the ability of the muscle to return to its resting length after being stretched. The last characteristic is extensibility, which allows a muscle to be stretch or lengthened when responding to an external force.[1] The above mentioned characteristics of muscle allow for 3 different types of dynamic muscle movements. They are concentric, eccentric, and isometric contractions.

Concentric contraction occurs when a muscle produces tension during a shortening movement allowing for acceleration of the body part. Eccentric contraction occurs when a muscle that produces tension is lengthening. Eccentric contraction is mainly used to help decelerate a

body part. Finally, isometric contraction occurs when a muscle contracts but does not change its length.[1] Plyometric exercise involves rapid changes of muscle contraction. Much of a participant's ability to maximize plyometric muscle strength relies on the Stretch-Shortening Cycle (SSC).

Stretch-Shortening Cycle

The stretch shortening cycle (SSC) is described as an eccentric phase or stretch followed by an isometric transitional period (amortization phase), leading into an explosive concentric action. The SSC goes together with plyometrics and is often referred to as the reversible action of muscles.[8]

Vertical jump performance relies heavily on the participant's ability to use the stretch-shortening cycle to increase vertical jump height.[10] The greater force produced by the muscle during plyometric training is related to the storage of elastic energy during muscle stretch and its rapid release during the shortening movement. When muscles undergo rapid eccentric elongation just before rapid concentric contraction it is known as the Stretch-Shortening Cycle (SSC).[10] The muscle is essentially stretched while active, resulting in a greater force production during the concentric contraction than could be

generated during a subsequent concentric contraction from a static position. If a muscle has the ability to adapt to this cycle it enables the individual performing the action to generate greater power.[11]

Most sports require jumping, sprinting, or rely on a combination of strength, speed, and power. Plyometric exercises are used to increase maximal power output and jumping ability.[10] Makaruk et al. performed a study using 44 non-training individuals. Subjects in the study performed plyometric exercises twice a week for 6 weeks. The measurements for this test included maximal power output, center of mass elevation, rebound time, and knee flexion angle. It was concluded that there was an increase in maximal power output during the counter jump movement and during depth jumps as well as a significant reduction of rebound time in the depth jump.[10] No significant changes in the center of mass elevation were noted in either jump.

Similarly, Lehnert et al. performed a study to find the validity of using plyometric training program and its effects on speed and explosive power in female youth volleyball athletes. Plyometric exercises were implemented twice a week for eight weeks. Their level of explosive power and locomotor speed was evaluated before, during and after the intervention was completed. The levels were

determined with the following tests: the standing vertical jump, the vertical jump with an approach and the shuttle run for 6 x 6 m. There were positive changes in the average values of test scores during the period of testing, but the dynamics of the changes in the explosive power and the speed were different.[12] Results from the study concluded plyometric training is effective in increasing power and speed in young female athletes. [12]

Design of Plyometric Training

There are many components within a plyometric training program, including progression. Progression within exercise can come from a variety of different ways such as changing weight, speed, intensity, duration or adding more exercises. When thinking of progression with plyometric training exercises you should consider intensity, volume, and recovery. A few common signs that an individual may not be ready to progress within their program are: 1).If the athlete shows extensive bending at the waist or her torso flops forward or from side-to side, more core work may be needed. 2). If the athlete exhibits prolonged contact with the floor, she may not have the overall body strength and power necessary to proceed. 3). If the athlete's knees are collapsing towards each other, this can mean lack of

quadriceps strength. The collapsing of the knees can occur on landing during the eccentric contraction or on push-off of the concentric phase. If the level of exercise is not decreased, these movements can lead to joint pain, tendonitis, excessive heaviness of the legs, and a decreased demonstrated ability to explode. Ideally, the knees should be aligned over the middle toe of each foot for all jumping and landing exercises. These progressions are all interrelated, the higher the intensity, the lower the volume, the longer rest period.[13]

Intensity is the amount of energy put forth to complete an exercise. In plyometrics, the intensity of a training session is determined by the exercises that are being performed or the rate of the SSC. Intensity has been defined as the amount of stress the plyometric drill places on the muscle, connective tissue, and joint.[13-14] Plyometric exercises can stretch from a wide variety of intensity. An exercise such as core twists would have low intensity whereas box jumps would have a very high intensity. Volume is also a vital piece to successful plyometrics.[13]

Within plyometrics the number of foot touches would account for the volume of a plyometric training exercise. The number of foot touches an individual may have may be dependent of factors such as age, weight, skill level, or

exercise preference.[13] Plyometrics can range from low to very high intensity. It is important to remember that in plyometrics, foot touches and volume are inversely related. Therefore, low intensity should be approximately 400 foot contacts a session, moderate intensity should be around 350 foot contacts a session, high intensity may consist of around 300 foot contacts a session, and very high intensity plyometrics should consist of about 200 foot contacts. The lower the number of foot contacts, the higher the intensity. Individuals with minimal experience using plyometrics should keep the ground contacts to less than 100 maximal efforts per session, whereas those with more experience could have as many as 120-140 maximal effort ground contracts per session.[15]

Recovery is essential to execute a successful plyometric training program.[9] When performing a plyometric program, recovery can have multiple meanings. Recovery can be the recovery time in between sets of an exercise and the rest time between workouts. In order to perform plyometric exercises correctly, the individual must have proper rest times in between exercises and proper recovery times after each workout. The effectiveness of a plyometric training session depends on maximal effort and a high speed of movement for each repetition. Rest intervals between

repetitions and sets should be long enough to allow almost complete recover.[16] As much as 5-10 seconds may be required between depth jumps and a work to rest ratio of 1:10 is recommended. For example, if a set of bounds takes 30 seconds to complete, the rest interval between sets would be 300 seconds or 5 minutes.[17] Without allowing for this proper rest interval, muscles may become over fatigued which may lead to poor technique which may result in injury.

A study performed by Luebbers and Potteiger focused on the importance of recovery time following a plyometric program. In the study, neither group showed an improvement immediately post training. However, when the subjects were allowed four weeks to recover, the study showed obvious effects that recovery can have on performance. It remains unclear if the results would have increased more with a longer recovery. What is clear however is that a recovery period should be included following a plyometric training program.[17]

Along with recovery, detraining effects can occur after a training program. Detraining may occur when an athlete reduces the training intensity, during, or ceases to train due to injury or illness.[18-19] Detraining can result in the loss of anatomical and physiological adaptations as

well as decrease performance.[18-19] The amount of detraining depends on the length of time and the training level of the athlete.[14]

A study performed by Faigenbaum et al demonstrated a very rapid and significant decrease in strength of preadolescence kids who trained for 8 weeks and were reevaluated 8 week after the training had ended.[18-19] A study performed by Kraemer et al[2]. investigated whether the was any change in vertical jump height after detraining occurred. The study showed that although there was no difference in jump height after 2 weeks, there was a reduction of 3-5% after 12 weeks.[2]

To help avoid detraining, athletes should often consider other methods of training. Although the exact mechanism for detraining is still not known, it is likely that changes in neuromuscular functioning are partially responsible.[20]

Plyometric Training Effects on the Lower Extremity

As mentioned earlier, plyometic training has many benefits that can help maximize athletic performance. Studies focusing on the benefits of plyometric training have found that this type of exercise can increase muscular power output, regulate lower extremity muscle co-

activation, and correct poor mechanics of the knee, ankle and hip.[2,9,11]

One of plyometric exercises known advantages is increasing muscle output. A recent study by Potteiger et al. examined changes in muscular power output and fiber characteristics following a 3 day a week, 8 week plyometric and aerobic exercise program in 19 physically active men. The plyometric training consisted of vertical jumping, bounding, and depth jumping. Muscle biopsies were collected from the vastus lateralis before and after training and type I and II fibers were identified. Peak muscle power output, measured using vertical jump significantly increased in both groups. The authors reported this may be in part to the reduced amortization phase between concentric and eccentric movements. A reduced amortization phase allows for greater increase power production. The study showed an increase of power output that may be related to an increase in muscle fiber size.[11]

Similar studies show supportive evidence of the effects of an 8 week training program.[12] Another common theory of plyometric training is it may increase changes in speed and explosive power. Over a course of 8 weeks Lehnert et al. examined muscle power and locomotor speed was before, during, and after a workout performed by youth

female volleyball players was complete. The individual's levels were measured by the standing vertical jump test, vertical jump with an approach, and a 6x6 shuttle. The results of the program supported the theory that plyometric exercises are effective in increasing explosive power and speed in young female athletes.[12]

Muscle co-activation has been shown to enhance neuromuscular performance and prevent knee injuries by increasing dynamic stability.[9] The objective of a study performed by Chimera et al. was to evaluate the effects of plyometric training on muscle activation strategies and performance of the lower extremity during jumping exercises. The subjects included in the study were Division 1 female college athletes. Female athletes are thought to have a greater risk of knee injury due to high adduction and abduction knee movements and increased landing force when compared to males. The participants performed plyometric exercises 2 times per week for 6 weeks. Surface electromyography was used to assess preparatory and reactive activity of the vastus medialis and vastus lateralis along with the medial and lateral hamstring and hip abductors and adductors. The results concluded that after the six week plyometric exercise, there were significant increases in firing of adductor

muscles during the preparatory phase. It was also concluded an increases in preparatory adductor to abductor muscle coactivation, and an increase in quadriceps to hamstring muscle coactivation.

Plyometric training induced beneficial neuromuscular adaptations in the hip adductor muscles that may assist with knee stability. Adductor muscle preactivation and adductor and abductor coactivation both increased after plyometric training. These neuromuscular adaptations, combined with previous kinematic and kinetic data strongly support the use of plyometric training to enhance dynamic restraint and functional stability at the knee joint.[16] These studies concluded that an increase in preparatory coactivation can be increased in plyometric training and may help reduce the risk of knee injuries in females.[9] One of the more common knee injuries theorized to be a result of poor muscle activation is non- contact ACL tears.

Non-contact ACL tears are especially common amongst female athletes. Non- contact ACL injuries in particular are often attributed to excessive knee valgus. Research shows females often land from a jump with increased knee valgus then males. It is believed that jump training with plyometrics can help reduce knee valgus during landing leading to a reduction of non-contact ACL tears in female

athletes. The purpose of a study performed by Harrington et al.[21] was to assess if a jump training program could have similar effects to those studies previously reported. Female athletes had their knee valgus angles assessed during two landing tasks. This was done by a two-dimensional frontal-plane projection angle of the knee. A digital camera was set up two meters anterior to the subjects knee. The digital images were imported into a digitizing software program (Quintic 4, Quintic Consultancy Ltd., United Kingdom). The angle between the lines formed between the markers at the anterior superior Iliac spine and middle of the tibiofemoral joint and that formed from the markers on the middle of the tibiofemoral joint to the middle of the ankle mortise was recorded as the valgus angle of the knee. Two tests were performed in this study. One was a drop jump and the other was a crossover hop. The jump training program lasted 4 weeks, 3 times a week. After training, the results showed significant decrease in knee valgus during landing from their pretest measures.[21]

Plyometric Training vs. Resistance Training

A popular training program for athletes, coaches, and strength and conditioning specialists is resistance

training. Resistance training will often use free weights or weight machines along with a slow controlled motion by the individual. Studies such as those performed by Vissing et al show plyometric training and traditional resistance training show specific benifits.[22] Vissing et al wanted to compare changes in muscle strength, power, and morphology induced by conventional strength training vs. plyometric training of equal time and effort requirements in 16 healthy males.[22] Those subjects who were in a conventional strength training group performed incline leg press, knee extension, hamstring curl. The plyometric group performed hurdle jumps, countermovement jumps and drop jumps. After 12 weeks of respective training, results concluded both conventional resistances training and plyometric training can benefit individuals. Moreover, the study went on to explain that both types of training increased gross muscle size, whereas only traditional resistance training increased cross-sectional area.

The study concluded that both traditional resistance training and plyometric training had very similar gains in muscle strength, whereas muscle power increased almost exclusively in plyometric training.[21] It is well documented that plyometric training is the best way to increase an individual's ability to increase jump height.[20] Enhancing

power performance allows an individual to rapidly accelerate their body during a dynamic movement such as a vertical jump. The increased power that leads to better acceleration can only be increased by plyometric training exercises.[1,2,21]

Brown et al also studied the different effects of resistive training and plyometric training in female dancers.[23] The purpose of the study was to observe the differences in performance found in female dancers who participated in either plyometric or traditional weight training. The plyometric group performed 3 sets of 8 repetitions of 4 different lower body plyometric exercises twice a week. The weight training group performed 3 sets of 6 to 8 repetitions of 4 lower body isotonic exercises twice a week. All subjects in the study performed testing prior to and post the 6 week work outs. The testing included in this study consisted of assessments of jumping skill and lower body strength and power. Strength was assessed via 3 one repetition max tests: using the leg press, leg curl and leg extension. Power was assessed with a wingate anaerobic power test and vertical jump height tests. Aesthetic jumping ability was assessed using 1 dance faculty member. The results showed there were no differences in the jumping ability, strength or power among

the groups at the start of the study. The plyometric group significantly increased leg press strength, standing vertical jump height, and aesthetic jump height. The weight training group significantly increased leg press, leg curl, mean aerobic power, and aesthetic jump height. Results showed that both weight training and plyometics have positive effects on vertical jumping ability.[22]

These two studies demonstrate plyometrics are not meant to be performed alone. They should be used along with other training methods such as strength, flexibility, and cardiovascular training. When plyometric drills are combined with a resistance training program, vertical jump performance appears to be enhanced to a significantly greater extent than if each of the training programs were performed alone.[24]

Coaches Knowledge of Plyometric Exercise

Recent studies and current literature prove plyometic exercise can increase athletic performance and decrease the risk of injury. What is not understood is why coaches may or may not have athletes perform plyometrics. Factors such as time, commitment, knowledge of plyometrics, or sports they coach may be factors. Although no current literature

has focused on coachs' knowledge of plyometric exercise, an emphasis of coaches' knowledge of concussions has been a recent topic. Although these two topics are not directly related, coaches' knowledge may be reasons why they do not have their athletes perform plyometric exercise.

Many studies have focused on coach's knowledge and management of sport related concussions. Studies have shown that coaches main weakness is that they believe all concussions may be treated the same.[25] This may be an indication that high school coaches understand the basics of a concussion but are unsure of how to follow up and manage an athlete with symptoms. These results may indicate that high school coaches may readily recognize concussion symptoms, and thus more attention may need to be given to educating coaches on the management of concussions to ensure they are equally confident in recognizing and treating concussive injuries in their athletes.[25]

Much like concussions, plyometric exercise also involves knowledge of many different domains of exercise. If coaches do not have the knowledge of the principles of plyometric exercise, they may either not feel confident in their ability to run plyometric exercises for their athletes or may be performing them incorrectly which could lead to injury.

Summary

Explosive power production is essential for maximal performance in many athletic events.[1] Plyometric exercises are defined as eccentric loading immediately followed by a concentric contraction.[9] Research has shown that plyometric training can increase maximal power output and also increase vertical jump height.

One of plyometric exercises most significant advantages is increasing muscle output. An increase in muscle output leads to greater power generated. Peak muscle power output, measured using a vertical jump significantly increased in groups performing plyometric exercise. This may be in part to the reduced amortization phase between concentric and eccentric movements. A reduced amortization phase allows for greater increase power production. An increase in power production may possibly be directly related to an increase in muscle fiber size and muscle output.[11]

The overall goal of plyometric training is to increase power output for individuals to increase jump height and maximize power. In studies performed showing gains in

athletes performing traditional weight lifting vs. plyometric exercise, it is well documented plyometric training is the best way to increase an individual's ability to increase jump height and maximal power.[20]

Plyometric training is an established technique that can be used to maximize athletic performance such as maximal power output and jumping ability as well as facilitate positive neuromuscular control to reduce injury and correct faulty jumping or cutting mechanics.

APPENDIX B

The Problem

STATEMENT OF THE PROBLEM

One of the primary training goals of plyometric exercises is to increase the maximal power output and jumping ability. Using plyometric training in a safe and correct manner has shown to produce multiple positive results such as improving explosive power, increasing vertical jump height, and agility, and developing faster contraction times with both slow and fast twitch muscle fibers.[4] Additionally, ploymetric exercise may lead to a decrease of lower extremity injuries. Coaches may be aware of plyometrics and how they can be used to help benefit athletes, but may not have the knowledge to perform them safely and effectively implement into their respective team workouts. Multiple training programs are easily available to high school coaches, but the extent of what they know about performing this type of exercise is still widely unknown. The purpose of this study is to determine coaches' level of knowledge when incorporating plyometric exercise training programs into their practices and conditioning.

Definition of Terms

The following definitions of terms are as defined for this study:

1. Concentric- A muscle contraction in which the muscle fibers pull together and shorten.[4]
2. Eccentric- A muscle contraction, which occurs when the muscle lengthens under tension.[4]
3. Myofibrils- Contractile structures composed of myofilaments.[4]
4. Golgi Tendon Organs-Receptors that are activated by stretch or active contraction of a muscle and that transmit information about muscle tension.[4]
7. Plyometrics- A type of exercise training designed to produce fast, powerful movements, and improve the functions of the nervous system, generally for the purpose of improving performance in sports.
8. Stretch shortening cycle- where the muscles involved are first stretched rapidly and then shortened to accelerate the body or limb.[10]

Basic Assumptions

The following are basic assumptions of this study:

1. The subjects of this study will complete the survey to the best of their ability.
2. The survey provided was valid and reliable.
3. Subjects did not use any outside resources to complete the survey.
4. Responses and demographic questions will be varied.

Limitations of the Study

The following are possible limitations of the study:

1. The results of the study are only valid for high school coaches in the state of Pennsylvania, results for other states cannot be generalized.
2. Coaches may choose to not respond to the online survey.
3. Athletic Directors will be responsible to forward the survey to their high school coaches.
4. Coaches may not have access to online survey.
5. Coaches may quit taking the survey at any time.
6. Time between survey validity was only 2 weeks.

Significance of the Study

It is vital that those who are training high school athletes understand the concept of plyometric exercise. Plyometric exercise gives athletes the opportunity to increase vertical jump height, maximal power output, and agility. If done incorrectly, this type of exercise can lead to improper mechanics or even injury. The results of this study may help identify knowledge of plyometric training among coaches at the high school level. The overall goal is to identify areas of the knowledge of plyometrics.

APPENDIX C

Additional Methods

APPENDIX C1

High School Coaches' Knowledge of Plyometic Exercise Survey

1. Are you willing to participate in this study? By checking "yes" you are implying informed consent to participate

- ◯ Yes
- ◯ No

2. Which category below describes your age?

- ◯ 17 or younger
- ◯ 18-20
- ◯ 21-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60 or older

3. Do you have your athletes perform plyometric training exercises as part of a training plan?

- ◯ Yes
- ◯ No

4. If you answered "No" to question 3, please briefly elaborate on why you do not:

5. If yes, who instructs and implements the training program

- ◯ Coach (Yourself)
- ◯ Assistant Coach
- ◯ Certified Strength and Conditioning Coach
- ◯ Nurse
- ◯ Athletic Trainer

Other (please specify)

Demographics

6. Are you male or female?

- ◯ Male
- ◯ Female

7. *4. Please check all sports that you coach:

- ◯ Football
- ◯ Volleyball
- ◯ Boys Track + Field
- ◯ Girls Track + Field
- ◯ Boys Soccer
- ◯ Girls Soccer
- ◯ Boys Cross Country
- ◯ Girls Cross Country
- ◯ Boys Basketball
- ◯ Girls Basketball
- ◯ Boys Swimming/Diving
- ◯ Girls Swimming/Diving
- ◯ Boys Tennis
- ◯ Girls Tennis
- ◯ Boys Golf
- ◯ Girls Golf
- ◯ Baseball
- ◯ Slow Pitch Softball
- ◯ Fast Pitch Softball
- ◯ Gymnastics
- ◯ Wrestling
- ◯ Mens Bowling
- ◯ Womens Bowling
- ◯ Mens Waterpolo
- ◯ Womens Waterpolo
- ◯ Mens Rifle
- ◯ Womens Rifle
- ◯ Mens Lacrosse

- ◯ Womens Lacrosse

8. Have you ever been a competitive athlete at the high school, college, or professional level?

- ◯ Yes
- ◯ No

9. If yes, did you ever perform plyometric training exercise as part of your warm-up or sport?

- ◯ Yes
- ◯ No

10. Have you had any formal training in plyometric exercise?

- ◯ Yes
- ◯ No

11. If yes, please elaborate on what type:

12. How many years have you been coaching?

- ◯ 0-5 years
- ◯ 5-10 years
- ◯ 10-15 years
- ◯ 20 or more years

13. Did you graduate college with any of the following degrees:

- ◯ Athletic Training
- ◯ Physical Therapy or Physical Therapy Assistant
- ◯ Fitness and Wellness
- ◯ Strength and Conditioning
- ◯ Exercise Science
- ◯ None of the above

Plyometric Training

14. The primary goals of plyometric exercise are?

	Increase in heart and lung function as well as increase in aerobic endurance	Maximal power output and increase oxygen transportation throughout the body (VO2 Max)	Maximal jumping ability and maximal power output	Maximal jumping ability and anerobic endurance	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

15. Plyometric Exercises should be performed in the following manner:

	Slow-Controlled manner	Explosive movement	Fast-Controlled manner	Do not know
Choose the BEST answer	◯	◯	◯	◯

16. Advantages to Plyometric Exercise include all of the following EXCEPT

	decrease muscle reflex inhibition	increase muscle tension receptor sensitivity (Golgi Tendon Organ)	increases muscle tension	decrease muscle lengthening sensitivity (Muscle Spindles)	Do not know
Choose the BEST answer	◯	◯	◯	◯	◯

17. The following are all types of dynamic muscle contraction EXCEPT:

	Concentric (Shortening of a muscle)	Eccentric (Lengthening of a muscle)	Isometic (No change in length of a muscle)	Dynamic (Active shortning and lengthing of a muscle) Do not know	Do not know
Choose the BEST answer	◯	◯	◯	◯	◯

18. Plyometrics heavily rely on all of the following physiological effects EXCEPT

	Stretch-Shortening Cycle (Active stretch of a muscle followed by an immediate shortening of that same muscle)	Reciprocal Inhibition (muscles on one side of a joint relaxing to accommodate contraction on the other side of that joint) Example: Quadricieps relaxing to accomidate hamstring contraction	Reflexes	Do not know
Choose the BEST answer	◯	◯	◯	◯

19. When designing progression in a plyometric training program, all of the following should be included except:

	Intensity (How long the progam will be)	volume (How many exercises are being done in a program)	recovery (How long of rests between exercises)	Individual age	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

20. Low intensity exercises should contain around how many foot touches?

	around 100	around 400	around 600	around 900	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

21. The proper rest ratio when performing plyometrics is:

	1:5	1:2	1:10	1:1	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

22. Within plyometric exercise, an increase in power output (ability of a muscle to produce a force) is directly related to:

	Increase in muscle fiber size	Increase in heart and lung output	decrease in body weight	Increase in Type 1 muscle fibers	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

23. Do you believe that female athletes land from a vertical jump differently than male athletes?

	Yes	No
Choose the BEST answer:	◯	◯

24. Plyometic Training has been shown to reduce which of the following common injuries in female athletes?

	Knee posterior cruciate ligament (PCL) tears	Muscle strains	ankle sprains	Knee anterior cruciate ligament (ACL) tears	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

25. Do you believe that female athletes have a greater risk of ACL injuries compared to their male counterparts?

	Yes	No
Choose the BEST answer:	◯	◯

26. Plyometric exercise is often a component of all of the following programs EXCEPT

	Stabilization (Ability to maintain one's balance)	Endurance (How long an individual can perform a specific exercise)	Power (How quickly a force can be exerted within a muscle)	Strength (How much force your muscles can produce)	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

27. The rapid switch from an eccentric contraction to a concentric contraction is known as:

	Amortization Phase	Peak Power Phase	Recruitment Phase	Loading Phase	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

28. Proprioceptive ability within plyometric exercise emphasis the importance of:

	Muscle Tension Receptors and Skin Pressure Receptors	Muscle Tension Receptors and Skin Temperature Receptors	Muscle Tension Receptors and Muscle Lengthening Receptors	Muscle Lengthening Receptors and Type I and II muscle fibers	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

29. To effectively progress an athlete through plyometric training, which is the correct order to progress an athete?

	Power, stabilization, strength	Strength, power, stabilization	Stabilization, power, strength	Stabilization, strength, power	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

30. Which of the following is NOT a plane of motion (Dynamic planes of motion that the body is capable of moving through)

	Sagittal (Dividing the body into right and left halves)	Oblique (Dividing the body by angles)	Frontal (Dividing the body into a front and back)	Transverse (Dividing the body into top and bottom)	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

31. Equal hip muscle activation ratios help control which other movement in the body?

	Hip flexion and extension	knee valgus/varus (Knock knee/bowlegged)	trunk rotation	knee flexion/extension	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

32. All of the following are signs that an individual is not ready to progress their training program EXCEPT

	Excessive bending at the waist during take off and landing	Prolonged contact with the floor	Fatigue	If individuals knees are collapsing inward during take off and landing	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

33. All of the following may occur if intensity is too high EXCEPT:

	Tendonitis	Unsafe drop of blood pressure	decreased ability to "explode" during jumping	Excessive heaviness of the legs	Do not know
Choose the BEST answer:	◯	◯	◯	◯	◯

APPENDIX C2

Institutional Review Board –

California University of Pennsylvania

California University of Pennsylvania

Proposal Number

Date Received

PROTOCOL for Research Involving Human Subjects

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects

(Reference IRB Policies and Procedures for clarification)

Project Title ***Knowledge of Plyometric Exercise amongst High School Coaches***

Researcher/Project Director ***Paul Rucci***

Phone # ***(207)944-4809*** ***E-mail Address*** ***ruc6286@calu.edu***

Faculty Sponsor (if required) ***Shelly DiCesaro***

Department ***Health Science***

Project Dates ***January 1, 2012*** ***to*** ***December 1, 2012***

Sponsoring Agent (if applicable) _____

Project to be Conducted at *California University of Pennsylvania (Via Internet)*

Project Purpose: ☒ ***Thesis*** ☐ ***Research*** ☐ ***Class Project*** ☐ ***Other***

Keep a copy of this form for your records.

Approved, September 12, 2005 / (updated 02-09-09)

Please attach a typed, detailed summary of your project AND complete items 2 through 6.

1. *Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(ses)or research questions that might be involved and explain how the information you gather will be analyzed. For a complete list of what should be included in your summary, please refer to Appendix B of the IRB Policies and Procedures Manual.*

The purpose of this study is to determine high school coaches' knowledge of plyometric exercise.

A descriptive design will be used in this study with data collected via a survey thru surveymonkey.com. The primary purpose of this study is to examine the knowledge of plyometric exercise among high school coaches. The dependent variable of this study is the coaches' knowledge of plyometric exercise. The independent variables of this study include: coaches' age, sex, years of experience, and the sport coached.

Subjects in this study will be composed of high school coaches who are in the Pennsylvania Interscholastic Athletic Association. Subjects will be notfied via e mail by Bob Bucknavage, PSADA Executive Director.

Prior to distribution of the survey, a review of the survey will be conducted using a panel of experts from California University of Pennsylvania. This panel has reviewed the survey and provided suggestions for improvements.

The Knowledge of Plyometric Training Survey (KPTS) will be used in this study. This survey was developed by the researcher for determining the knowledge of plyometric training among high school coaches. The questionaire asks for information regarding gender of the coach, number of years of coaching experience at the high school level, gender of the sports they coach, what specific sports they coach, and questions based on specific plyometric exercises.

The follwing steps to distribute the survey will be performed by the researcher:

1. The researcher will utilize surveymonkey.com by creating a direct link with a cover letter developed by the researcher.

2. A cover letter containing the direct link to surverymonkey.com will be sent to Bob Bucknavage, PSADA Executive Director.

3. Bob Bucknavage will forward the cover letter to all high school athletic directors in the Pennsylvania Interscholastic Athletic Association.

4. The high school athletic directors will distribute the email to their respective high school coaches.

5. High school coaches will then complete the online survey.

6. A 'reminder' email will be sent to the coaches to complete the survery at weeks 1 and 2 after original distribution.

The coverletter will explain the purpose of the study and reasons why coaches should consider participating. All surveys will be received by the researcher anonymously and will be confidential. The results of the survey will only be accessable with a correct usernamc and password. Once the data collection process is complete, the researcher will download the data to SPSS for data anaylsis.

The following hypotheses were based on previous research and the researchers intuition based on a review of the literature:

1. There will be no significant difference in plyometric knowledge survey scores between coaches based on gender at the high school level.

2. There will be no significant difference in plyometric knowledge survey scores between coaches involved in female versus male sports at the high school level.

3. There will be no significant difference in plyometric knowledge survey scores between coaches based on number of years coaching.

4. There will be no significant difference in plyometric knowledge survey scores between coaches of specific sports.

All data will be analyzed by SPSS version 18.0 for windows at an alpha level of 0.05. The research hypothesis will be analyzed using a repeated measures analysis of variance.

2. *Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.*

   a. *How will you insure that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.*

      Risks to subjects are minimal in this study. The survey that will be administered will contain items pertaining only to the relavance of the study. To minimize any risks, information gathered from the study will remain password protected and be saved on a California University server. All information will be received anonymously with no identifiable information.

   b. *How will you insure that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.*

      The selection of subjects will be equitable because the study will be sent electronically to all high school coaches in the state of Pennsylvania.

   c. *How will you obtain informed consent from each participant or the subject's legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.*

      Informed consent will be implied by voluntarily choosing to complete the provided survey. The survey cover letter will explain this, as will the first page of the electronic survey.

   d. *Show that the research plan makes provisions to monitor the data collected to insure the safety of all subjects. This includes the privacy of subjects' responses and provisions for maintaining the security and confidentiality of the data.*

      The names of the surveys subjects will not be included on the survey. The responses of the subjects will be collected through the use of Survey Monkey and access will be password protected. All data collected from the survey will be stored on University servers in password protected files.

3. *Check the appropriate box(es) that describe the subjects you plan to use.*

☒ *Adult volunteers*	☐ *Mentally Disabled People*
☐ *CAL University Students*	☐ *Economically Disadvantaged People*
☐ *Other Students*	☐ *Educationally Disadvantaged People*
☐ *Prisoners*	☐ *Fetuses or fetal material*
☐ *Pregnant Women*	☐ *Children Under 18*
☐ *Physically Handicapped People*	☐ *Neonates*

4. *Is remuneration involved in your project?* ☐ *Yes or* ☒ *No. If yes, Explain here.*

5. *Is this project part of a grant?* ☐ *Yes or* ☒ *No If yes, provide the following information:*

   Title of the Grant Proposal _____

   Name of the Funding Agency _____

   Dates of the Project Period _____

6. *Does your project involve the debriefing of those who participated?* ☐ *Yes or* ☒ *No*

   If Yes, explain the debriefing process here.

7. *If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix___in the Policies and Procedures Manual.*

California University of Pennsylvania Institutional Review Board
Survey/Interview/Questionnaire Consent Checklist (v021209)

This form MUST accompany all IRB review requests

Does your research involve ONLY a survey, interview or questionnaire?
☒ **YES**—Complete this form
☐ **NO**—You MUST complete the "Informed Consent Checklist"—skip the remainder of this form

Does your survey/interview/questionnaire cover letter or explanatory statement include:

☒ (1) Statement about the general nature of the survey and how the data will be used?

☒ (2) Statement as to who the primary researcher is, including name, phone, and email address?

☒ (3) FOR ALL STUDENTS: Is the faculty advisor's name and contact information provided?

☒ (4) Statement that participation is voluntary?

☒ (5) Statement that participation may be discontinued at any time without penalty and all data discarded?

☒ (6) Statement that the results are confidential?

☒ (7) Statement that results are anonymous?

☒ (8) Statement as to level of risk anticipated or that minimal risk is anticipated? (NOTE: If more than minimal risk is anticipated, a full consent form is required—and the Informed Consent Checklist must be completed)

☒ (9) Statement that returning the survey is an indication of consent to use the data?

☒ (10) Who to contact regarding the project and how to contact this person?

☒ (11) Statement as to where the results will be housed and how maintained? (unless otherwise approved by the IRB, must be a secure location on University premises)

☒ (12) Is there text equivalent to: "Approved by the California University of Pennsylvania Institutional Review Board. This approval is effective nn/nn/nn and expires mm/mm/mm"? (the actual dates will be specified in the approval notice from the IRB)?

☒ (13) FOR ELECTRONIC/WEBSITE SURVEYS: Does the text of the cover letter or explanatory statement appear before any data is requested from the participant?

☒ (14) FOR ELECTONIC/WEBSITE SURVEYS: Can the participant discontinue participation at any point in the process and all data is immediately discarded?

California University of Pennsylvania Institutional Review Board
Informed Consent Checklist (v021209)

This form MUST accompany all IRB review requests

Does your research involve ONLY a survey, interview, or questionnaire?
☒ **YES**—DO NOT complete this form. You MUST complete the "Survey/Interview/Questionnaire Consent Checklist" instead.
☐ **NO**—Complete the remainder of this form.

1. **Introduction** (check each)
   - ☐ (1.1) Is there a statement that the study involves research?
   - ☐ (1.2) Is there an explanation of the purpose of the research?

2. **Is the participant.** (check each)
   - ☐ (2.1) Given an invitation to participate?
   - ☐ (2.2) Told why he/she was selected.
   - ☐ (2.3) Told the expected duration of the participation.
   - ☐ (2.4) Informed that participation is voluntary?
   - ☐ (2.5) Informed that all records are confidential?
   - ☐ (2.6) Told that he/she may withdraw from the research at any time without penalty or loss of benefits?
   - ☐ (2.7) 18 years of age or older? (if not, see Section #9, Special Considerations below)

3. **Procedures** (check each).
   - ☐ (3.1) Are the procedures identified and explained?
   - ☐ (3.2) Are the procedures that are being investigated clearly identified?
   - ☐ (3.3) Are treatment conditions identified?

4. **Risks and discomforts**. (check each)
   - ☐ (4.1) Are foreseeable risks or discomforts identified?
   - ☐ (4.2) Is the likelihood of any risks or discomforts identified?
   - ☐ (4.3) Is there a description of the steps that will be taken to minimize any risks or discomforts?
   - ☐ (4.4) Is there an acknowledgement of potentially unforeseeable risks?
   - ☐ (4.5) Is the participant informed about what treatment or follow up courses of action are available should there be some physical, emotional, or psychological harm?
   - ☐ (4.6) Is there a description of the benefits, if any, to the participant or to others that may be reasonably expected from the research and an estimate of the likelihood of these benefits?
   - ☐ (4.7) Is there a disclosure of any appropriate alternative procedures or courses of treatment that might be advantageous to the participant?

5. **Records and documentation**. (check each)
   - ☐ (5.1) Is there a statement describing how records will be kept confidential?
   - ☐ (5.2) Is there a statement as to where the records will be kept and that this is a secure location?
   - ☐ (5.3) Is there a statement as to who will have access to the records?

6. For research involving more than minimal risk (check each),

☐ (6.1) Is there an explanation and description of any compensation and other medical or counseling treatments that are available if the participants are injured through participation?

☐ (6.2) Is there a statement where further information can be obtained regarding the treatments?

☐ (6.3) Is there information regarding who to contact in the event of research-related injury?

7. Contacts.(check each)

☐ (7.1) Is the participant given a list of contacts for answers to questions about the research and the participant's rights?

☐ (7.2) Is the principal researcher identified with name and phone number and email address?

☐ (7.3) FOR ALL STUDENTS: Is the faculty advisor's name and contact information provided?

8. General Considerations (check each)

☐ (8.1) Is there a statement indicating that the participant is making a decision whether or not to participate, and that his/her signature indicates that he/she has decided to participate having read and discussed the information in the informed consent?

☐ (8.2) Are all technical terms fully explained to the participant?

☐ (8.3) Is the informed consent written at a level that the participant can understand?

☐ (8.4) Is there text equivalent to: "Approved by the California University of Pennsylvania Institutional Review Board. This approval is effective nn/nn/nn and expires mm/mm/mm"? (the actual dates will be specified in the approval notice from the IRB)

9. Specific Considerations (check as appropriate)

☐ (9.1) If the participant is or may become pregnant is there a statement that the particular treatment or procedure may involve risks, foreseeable or currently unforeseeable, to the participant or to the embryo or fetus?

☐ (9.2) Is there a statement specifying the circumstances in which the participation may be terminated by the investigator without the participant's consent?

☐ (9.3) Are any costs to the participant clearly spelled out?

☐ (9.4) If the participant desires to withdraw from the research, are procedures for orderly termination spelled out?

☐ (9.5) Is there a statement that the Principal Investigator will inform the participant or any significant new findings developed during the research that may affect them and influence their willingness to continue participation?

☐ (9.6) Is the participant is less than 18 years of age? If so, a parent or guardian must sign the consent form and assent must be obtained from the child

- ☐ Is the consent form written in such a manner that it is clear that the parent/guardian is giving permission for their child to participate?
- ☐ Is a child assent form being used?
- ☐ Does the assent form (if used) clearly indicate that the child can freely refuse to participate or discontinue participation at any time without penalty or coercion?

☐ (9.7) Are all consent and assent forms written at a level that the intended participant can understand? (generally, 8th grade level for adults, age-appropriate for children)

California University of Pennsylvania Institutional Review Board
Review Request Checklist (v021209)

This form MUST accompany all IRB review requests.
Unless otherwise specified, ALL items must be present in your review request.

Have you:

☒ (1.0) FOR ALL STUDIES: Completed ALL items on the Review Request Form?
Pay particular attention to:

- ☒ (1.1) Names and email addresses of all investigators
  - ☒ (1.1.1) FOR ALL STUDENTS: use only your CalU email address)
  - ☒ (1.1.2) FOR ALL STUDENTS: Name and email address of your faculty research advisor
- ☒ (1.2) Project dates (must be in the future—no studies will be approved which have already begun or scheduled to begin before final IRB approval—NO EXCEPTIONS)
- ☒ (1.3) Answered completely and in detail, the questions in items 2a through 2d?
  - ☒2a: NOTE: No studies can have zero risk, the lowest risk is "minimal risk". If more than minimal risk is involved you MUST:
    - ☐ i. Delineate all anticipated risks in detail;
    - ☐ ii. Explain in detail how these risks will be minimized;
    - ☐ iii. Detail the procedures for dealing with adverse outcomes due to these risks.
    - ☐ iv. Cite peer reviewed references in support of your explanation.
  - ☒ 2b. Complete all items.
  - ☒ 2c. Describe informed consent procedures in detail.
  - ☒ 2d. NOTE: to maintain security and confidentiality of data, all study records must be housed in a secure (locked) location ON UNIVERSITY PREMISES. The actual location (department, office, etc.) must be specified in your explanation and be listed on any consent forms or cover letters.
- ☒ (1.4) Checked all appropriate boxes in Section 3? If participants under the age of 18 years are to be included (regardless of what the study involves) you MUST:
  - ☐ (1.4.1) Obtain informed consent from the parent or guardian—consent forms must be written so that it is clear that the parent/guardian is giving permission for their child to participate.
  - ☐ (1.4.2) Document how you will obtain assent from the child—This must be done in an age-appropriate manner. Regardless of whether the parent/guardian has given permission, a child is completely free to refuse to participate, so the investigator must document how the child indicated agreement to participate ("assent").
- ☐ (1.5) Included all grant information in section 5?
- ☒ (1.6) Included ALL signatures?

☐ (2.0) FOR STUDIES INVOLVING MORE THAN JUST SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:

- ☐ (2.1) Attached a copy of all consent form(s)?
- ☐ (2.2) FOR STUDIES INVOLVING INDIVIDUALS LESS THAN 18 YEARS OF AGE: attached a copy of all assent forms (if such a form is used)?
- ☐ (2.3) Completed and attached a copy of the Consent Form Checklist? (as appropriate—see that checklist for instructions)

☒ (3.0) FOR STUDIES INVOLVING ONLY SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:

- ☒ (3.1) Attached a copy of the cover letter/information sheet?
- ☒ (3.2) Completed and attached a copy of the Survey/Interview/Questionnaire Consent Checklist? (see that checklist for instructions)
- ☒ (3.3) Attached a copy of the actual survey, interview, or questionnaire questions in their final form?

☒ (4.0) FOR ALL STUDENTS: Has your faculty research advisor:

- ☒ (4.1) Thoroughly reviewed and approved your study?
- ☒ (4.2) Thoroughly reviewed and approved your IRB paperwork? including:
  - ☒ (4.2.1) Review request form,
  - ☐ (4.2.2) All consent forms, (if used)
  - ☐ (4.2.3) All assent forms (if used)
  - ☒ (4.2.4) All Survey/Interview/Questionnaire cover letters (if used)
  - ☒ (4.2.5) All checklists
- ☒ (4.3) IMPORTANT NOTE: Your advisor's signature on the review request form indicates that they have thoroughly reviewed your proposal and verified that it meets all IRB and University requirements.

☒ (5.0) Have you retained a copy of all submitted documentation for your records?

Project Director's Certification

Program Involving HUMAN SUBJECTS

The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

I understand that Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any change in the research plan that affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems that arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board in its effort to provide a continuing review after investigations have been initiated.

I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

Professional Research

Project Director's Signature

Department Chairperson's Signature

Student or Class Research

Student Researcher's Signature

Supervising Faculty Member's Signature if required

Department Chairperson's Signature

ACTION OF REVIEW BOARD (IRB use only)

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

1. provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. uses appropriate methods to obtain informed, written consent;
3. indicates that the potential benefits of the investigation substantially outweigh the risk involved.
4. provides adequate debriefing of human participants.
5. provides adequate follow-up services to participants who may have incurred physical, mental, or emotional harm.

☐ Approved[_____] ☐ Disapproved

Chairperson, Institutional Review Board

Date

Approved, September 12, 2005 / (updated 02-09-09)

Institutional Review Board
California University of Pennsylvania
Morgan Hall, Room 310
250 University Avenue
California, PA 15419
instreviewboard@calu.edu
Robert Skwarecki, Ph.D., CCC-SLP,Chair

Dear Paul Rucci:

Please consider this email as official notification that your proposal titled "Knowledge of Plyometric Exercises amongst High School Coaches" (Proposal #11-041) has been approved by the California University of Pennsylvania Institutional Review Board as amended.

The effective date of the approval is 2-02-2012 and the expiration date is 2-01-2013. These dates must appear on the consent form .
Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:

(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)
(2) Any events that affect the safety or well-being of subjects
(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).
(4) To continue your research beyond the approval expiration date of 2-01-2013 you must file additional information to be considered for continuing review. Please contact instreviewboard@calu.edu

Please notify the Board when data collection is complete.
Regards,
Robert Skwarecki, Ph.D., CCC-SLP
Chair, Institutional Review Board

APPENDIX C3

COVER LETTER

California University of Pennsylvania

Dear High School Coach:

My name is Paul Rucci and I am currently a graduate student at California University of Pennsylvania pursing a Master of Science degree in Athletic Training. Part of the graduate study curriculum is to complete a research thesis through research and I am conducting survey research to determine high school coaches' knowledge of plyometric exercise.

High school coaches in the state of Pennsylvania are being asked to participate in this research; however, your participation is voluntary and you do have the right to choose not to participate. You also have the right to discontinue participation at any time during the survey completion process at which time your data will be discarded. The California University of Pennsylvania Institutional Review Board has reviewed and approved this project. The approval is effective 02/02/2012 and expires 02/02/2013

Data will be collected online via surveymonkey and will be kept confidential and anonymous. Informed consent to use the data collected will be assumed upon return of the survey. Aggregate survey responses will be housed in a password protected file on the CalU campus. Minimal risk is posed by participating as a subject in this study. I ask that you please take this survey at your earliest convenience as it will take approximately 20 minutes to complete. If you have any questions regarding this project, please feel free to contact the primary researcher, Paul Rucci at RUC6286@calu.edu or by phone at (207) 944-4809. You can also contact the faculty advisor for this research Shelly DisCesaro at dicesaro@calu.edu. Thank you in advance for your participation. Please click the following link to access the survey (https://www.surveymonkey.com/s/LLCQ75C)

Again, thank you for taking the time to take part in my thesis research. I greatly appreciate your time and effort put into this task. The survey can be found at https://www.surveymonkey.com/s/LLCQ75C

Sincerely,

Paul Rucci, ATC
Primary Researcher
California University of Pennsylvania
250 University Ave
California, PA 15419
(207) 944-4809
RUC6286@calu.edu

APPENDIX C4

REFERENCES

REFERENCES

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ABSTRACT

Title: High School Coaches' Knowledge of Plyometric Exercise

Researcher: Paul Rucci

Advisor: Dr. Shelly DiCesaro

Research Type: Master's Thesis

Context: In light of the economic crisis Pennsylvania school are facing, budgets do not normally afford strength and conditioning coaches. Therefore, high school coaches may often be leading conditioning programs, including plyometric exercise for their athletes. However, it is unknown if coaches actually do include plyometric programs into their practice or if they have the proper knowledge of plyometrics to implement them in a safe and effective manner.

Objective: The purpose of this study was to identify high school coaches in Pennsylvania that use plyometric exercises as part of their workouts for high school athletes and gain a better understanding of their level of knowledge with this type of training.

Design: Descriptive research study

Setting: The survey was distribute via email to high school coaches in the state of Pennsylvania

Subjects: High school coaches from the state of Pennsylvania in the PIAA were surveyed for this study.

Interventions: The independent variables for this study were 1) high school coaches' gender, 2) high school coaches' gender of sport they coach, and 3) high school coaches' age group. This survey was conducted via an online survey program. The survey was distributed to high school athletic directors in the PIAA who in turn, forwarded the survey link to their coaches'. The survey was open for 4 weeks with a reminder email sent at 2 weeks into the survey.

Measurements: All data was analyzed via SPSS version 18 with an alpha level of 0.05 Coaches gender and sport gender

coached was evaluated via a *one way independent t-test.* High school coach's age group was evaluated utilizing an *ANOVA.*

Results: P-values of the first two interventions were p=.188, and p=.170 respectively showing no sign of significance. The significance found in the 3rd intervention, p=.976 was also not significant.

Conclusion: Although no significance was found in the study, it is worth noting that coaches scored A mean o f6 out of 20 answers correctly in the survey. This may indicate that coaches need to be educated regarding plyometric exercise and implementation into daily practices.