THE EFFECTS OF A 6-WEEK IN-SEASON OLYMPIC/RESISTANCE TRAINING PROGRAM VERSUS A 6-WEEK PLYOMETRIC/RESISTANCE TRAINING PROGRAM IN COLLEGIATE CLUB RUGBY UNION PLAYERS

A Thesis

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Taylor Creed Catrett

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THE EFFECTS OF A 6-WEEK IN-SEASON OLYMPIC/RESISTANCE TRAINING PROGRAM VERSUS A 6-WEEK PLYOMETRIC/RESISTANCE TRAINING PROGRAM IN COLLEGIATE CLUB RUGBY UNION PLAYERS

A Thesis

by

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_________________________________________________________________________

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Department of Kinesiology
Abstract

of

THE EFFECTS OF A 6-WEEK IN-SEASON OLYMPIC/RESISTANCE TRAINING PROGRAM VERSUS A 6-WEEK PLYOMETRIC/RESISTANCE TRAINING PROGRAM IN COLLEGIATE CLUB RUGBY UNION PLAYERS

by

Taylor C. Catrett

The purpose of this study was to investigate an in-season strength program and the effects of additional Olympic lifts versus Plyometric jumps on vertical jump, broad jump, and 40-meter sprint performance in collegiate club rugby players. This was a 6-week training program where the athletes lifted two times a week in their respective groups. Thirty-one collegiate club rugby players started this program but only 24 finished (Olympic/resistance group, N = 13; Plyometric/resistance group, N = 11). At the beginning and end of the 6-week training program all participants were pre- and post-tested in the vertical jump, broad jump, and 40-meter sprint.

The results of this study concluded that there were no significant statistical changes (P < 0.05) within or between either groups in the vertical or broad jump. The data did reveal a significant statistical difference within each respective group for the 40-meter
(Oly p = 0.01; Plyo = 0.02) sprint but no significance was found between the two groups for the 40-meter sprint. Further research should be conducted using similar testing protocols that are found in other researched literature; of which, the present researcher did not have access to. Researching off- and pre-season in this population would also be recommended to see the carryover into the competitive season of club rugby.

_______________________, Committee Chair
Harry Theodorides, Ed. D

_______________________
Date
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Chapter 1

INTRODUCTION

Rugby is an emerging sport within the United States, despite it being the second most popular sport in the world, soccer being the first (Carney, Smolianov, & Zakus, 2012; Kerr et al., 2008). In 1975 USA Rugby was formed as the governing body of the sport and was created for the development and incursion of the game of rugby into the United States (USA Rugby Strategic Plan, 2013). USA Rugby is responsible for all levels of play, including collegiate club rugby teams. As of 2012 there were around 115,000 active members and upwards of 900 college teams (USA Rugby Strategic Plan, 2013; SGMA Research/Sport Marketing Surveys, 2011). College players must become members of the USA Rugby and pay the membership fee to play rugby. College clubs are given rules to follow and structure for leagues and conferences by USA Rugby, as it is the NCAA’s stance that NCAA does not fully recognize rugby as a varsity sport (Kerr et al., 2008; MacQueen & Dexter, 2010). Collegiate clubs mostly run on self-raised money, players fees, alumni donations, and with some help from their respective college sport club organization (Sac State Sport Clubs Council, 2014). Even though rugby union is increasing in notoriety and popularity, it is still not given the attention that other varsity collegiate sports get. This has left rugby and other collegiate club sports at a disadvantage in the opportunity of quality strength and conditioning coaching. In many cases, clubs do not receive any help with strength and conditioning coaching or facilities to train in.
Rugby is a collision sport that demands power, strength, speed, agility, and endurance (Argus, Gill, Keogh, McGuigan, Hopkins, & Beaven, 2009; Baker, 1998; Baker, 2001). It is of primary importance for the rugby players to have the highest levels of these variables in order to be successful at the sport (Argus, Gill, Keogh, Hopkins, & Beaven, 2010; Gabbett, 2006; Gamble, 2004; Stone et al., 2006). It is the strength and conditioning professional’s challenge to program training that maximizes the performance of the players. During the competitive season it is important that the players lift for maintenance or improvement of their strength, power, performance, and injury prevention (Argus, Gill, Keogh, McGuigan, & Hopkins, 2012). There is also a lack of literature coming from researchers in the United States on the study of sport performance within this population (Carney, Smolianov, & Zakus, 2012). It is the secondary purpose of this study to provide collegiate club rugby teams with an option of an in-season program that has been scientifically studied and tested.

Purpose of the Study

The purpose of this study was to examine the effect of an in-season 6-week strength and Olympic weightlifting-training program versus a strength and plyometric-training program on sport specific performance in collegiate club rugby players.

Significance of the Study

The significance of this study was to add to the field of strength and conditioning for in-season training programs specifically in the collegiate club rugby class. As rugby is a growing sport, the opportunities to play rugby are increasing as well. The NCAA does not sanction most collegiate club teams, therefore the funding and school
involvement is lacking. Many teams are not given opportunity to have the strength and conditioning coaches in the athlete’s training facility and may be lacking a specialized training program. This study used findings from the current literature of training programs for a rugby teams in order to investigate a practical program for in-season strength training. This was done in hopes that current collegiate club rugby coaches, who lack the availability of strength coaches and may lack strength and conditioning knowledge, may implement this program and contribute to club rugby by possibly providing such teams a program to follow while in competition. Also this study will add to the body of research of the training effects on collegiate club rugby players within the United States, which has been found lacking in the literature.

Assumptions

1. All participants will be practicing and conditioning as a team and playing in one match per week.
2. All participants will provide their maximal effort during the pre- and post-tests.
3. All participants will provide their time and maximal effort while participating in the training session.
4. All athletes will attend all training sessions, twice a week for 6 weeks.
5. All participants will refrain from any other type of training and conditioning outside of the training sessions, practices, and matches.

Limitations

1. Injuries obtained during the time of the study during matches or practices.
2. The pre-season fitness level of the participants.
Delimitations

1. The participants of this study will consist of collegiate club ruby players.
2. The rugby players had no requirement of rugby experience at any level of play.

Hypotheses

It is the stance of this study that the hypothesis will be null to include the following:

1. There will be no statistically significant difference within the vertical jump scores of the two groups.
2. There will be no statistically significant difference between the vertical jump scores of the two groups.
3. There will be no statistically significant difference within the broad jump scores of the two groups.
4. There will be no statistically significant difference between the broad jump scores of the two groups.
5. There will be no statistically significant difference within the 40-meter sprint times of the two groups.
6. There will be no statistically significant difference between the 40-meter sprint times of the two groups.

Definition of Terms

Olympic Weightlifting – An athletic discipline that tests explosive strength with high force and high velocity movements with a barbell.
Plyometric training – also known as jump training, are exercises that exert maximum muscular force in short intervals of time, are explosive in manner.

Vertical Jump Height – The greatest height achieved when a person jumps up vertically and reaches up with their arm to hit or touch a measured point. This number is subtracted from their standing reach to get the vertical jump height.

Broad Jump Distance – The measured distance a person can jump forward from a standstill by using an arm swing and pushing off the ground with both feet.

Collegiate Club Rugby – An organized team of collegiate players that are participating in rugby competitions. These teams are not organized or funded by the NCAA.

NSCA – National Strength and Conditioning Association

USAW – United States of America Weightlifting

PAR-Q – Physical Activity Readiness Questionnaire

NCAA – National Collegiate Athletic Association

Reps – repetitions: number of times a lift is performed in one set

Set – number of times to complete a given number of reps

RM – Repetition Maximum
Chapter 2
REVIEW OF LITERATURE

This review of literature begins with a discussion of the training considerations for the sports of rugby and the demands that a match has on the players. This review of literature focuses on research that has assisted strength and conditioning professionals in becoming efficient at strengthening or maintaining an athlete’s strength, power, and speed during the competitive season. The purpose of this study was to examine the effects of a 6-week in-season Olympic/resistance training program versus a 6-week in-season plyometric/resistance training program on sport specific performance in collegiate club rugby players.

In-Season Training Considerations

There has been an increasing body of research showing the beneficial effects of a strength and power training program during the competitive season (Argus, Gill, Keogh, McGuigan, and Hopkins, 2012; Argus, Gill, Keogh, McGuigan, Hopkins, & Beaven, 2009; Baker, 1998; Baker, 2001; Hartwig, Nauhgton, & Searl, 2008; Hedrick, 2005; Hoffman & Kang, 2003; Marshall, 2005; McMaster, Gill, Cronin, & McGuigan, 2013). The number of recommended in-season strength and power training days ranges from one to three (Argus, Gill, Keogh, McGuigan, & Hopkins, 2012; Argus, Gill, Keogh, McGuigan, Hopkins, & Beaven, 2009; Baker, 2001; Hartwig, Nauhgton, & Searl, 2009; Hedrick, 2005; Hoffman & Kang, 2003; Marques, Van Den Tillaar, Vescovi, & Gonzalez-Badillo, 2008; Marshall, 2005; McMaster, Gill, Cronin, & McGuigan, 2013; Mujika, Santisteban, & Castagna, 2009; Schneider, Arnold, Martin, Bell, & Crocker,
Many studies have used programs consisting of two days a week (Baker, 1998, Duehring, Feldman, & Ebben, 2009; Hoffman & Kang, 2003; Marques, Van Den Tillaar, Vescovi, & Gonzalez-Badillo, 2008; Mujika, Santisteban, & Castagna, 2009; Schneider, Arnold, Martin, Bell, & Crocker, 1998). Argus, Gill, Keogh, McGuigan, and Hopkins (2012) found that elite level rugby union players increased performance measures on the weighted countermovement jump (12%) and weighted squat jump (11%) during an in-season contrast training program where higher volume-load programming was used. Argus, Gill, Keogh, Hopkins, and Beaven (2009) suggested that two days a week of resistance training may be adequate for maintenance of power and strength but in order to improve power and strength, two or more days, or two days of resistance training plus a day of field work (weighted sled pulling), may be needed.

When a strength and conditioning coach plans an in-season training program their goals are to maintain the strength, power, and muscle mass that the athlete has developed during the off- and pre-season lifting phases (Argus, Gill, Keogh, Hopkins, & Beaven, 2009, Baker, 1998; Marshall, 2005). Other goals are to include enhancement of recovery and injury prevention (Hedrick, 2005; Wrigley, Drust, Stratton, Scott, & Gregson, 2012). According to a comparison study by Naclerio et al. (2013) between high volume, medium volume, and low volume resistance training effects, a low volume program using an intensity of 75% of 1 RM could be effective for increasing power performance in team sport athletes with little to no resistance training experience. Gabbett and Domrow (2007) also stated that training loads should be decreased during early competition phases if maintaining or developing agility and injury prevention is the priority. Argus et al.
(2009) utilized an in-season training program of 3-7 sets of 2-6 repetitions for 4-6 strength exercises, 3 sets of 4-6 reps at 50-70% 1RM for 3-4 power exercises, and 20-30 minutes of 5- to 20- second sprints at 1-2 days a week with a 1:2 work to rest ratio. This was with elite-level rugby players that also had the built in recovery days for rehab and therapy.

Baker (1998) suggested using a periodized wavelike progression overload during in-season training. Baker’s argument was that if the in-season performance depended on strength and power, then these variables must be maintained during a competitive season. Baker used low volumes and high intensities in his proposed model of wavelike periodization, which he developed for the use in American football that he also used for amateur and professional rugby players in Australia. Baker stated that this method maintained his players’ strength at 99.7% of their pre-season strength. This program used 6-week macrocycles split up into 3-week mesocycles with a build up toward peak intensities. Training was programmed to take place two days a week with 3 sets of each exercise, excluding the warm up sets, being performed where each set increases in intensity. The first three weeks built up in intensity with week four dropping down in intensity to a similar week 2. Baker also distinguished certain exercises as core strength: squats and bench press; core power: power clean, hang clean, power snatch, and jerk; assistant strength: press, incline bench press, rows, and chin ups; and assistant power: pulls, power shrugs, and push press. Every exercise was loaded with parameters of repetitions that were to elicit strength, power maintenance, or hypertrophy. A methodical manipulation in the wavelike periodization of the repetitions was done to allow for
maintenance of strength, neuromuscular stimulation, and greater power outputs in the Olympic lifts, and central nervous system relaxation. This design was also made for a strength coach to be able to prescribe loads based on the how the athlete feels and from the previous training performance. Baker (1998) showed tables 1 and 2 (p.19 and 20) representing the sets, reps, and intensities and makes a point that the numbers that represent the intensities are not for true adherence it is there to signify progression in the overload. In validating the model used, Baker stated that his rugby players who used this program were able to minimally increase their strength while in-season and that the injury rate was at a record low. This statement is in agreement with what other studies have shown to be the case for in-season training (Hedrick, 2005; Wrigley, Drust, Stratton, Scott, & Gregson, 2012).

Power Demands

Power is a product of speed (velocity) and strength (force) as it works against a load (Baker, 1998; Hansen & Cronin, 2009; Stone et al., 2006). Power is important to be successful in a sport such as rugby (Baker & Newton, 2008; Comfort, Graham-Smith, Matthews, & Bamber, 2011). Rugby players need high levels of power in order to complete the tackles, lifts in the lineout, pushing and driving in the scrums and mauls, and to react to the play of the ball (Argus, Gill, Keogh, McGuigan, and Hopkins, 2012; Gabbett, Johns, & Riemann, 2008; Smart & Gill, 2013). Closed-chain exercises that are ground based and use multiple joints at the same time are responsible for abilities to overcome opposing forces. Being strong, fast, and able to exert high amounts of power and force can make a great athlete (Argus, Gill, Keogh, & Hopkins, 2011). Power
phases are implemented into the workout program after strength and endurance bases are set. Cormie, McGuigan, and Newton (2011) stated that a high level of power could not exist without a base of strength, as there is an intense relationship between the two. Power production is gained by the implementation of Olympic lifts such as the clean, snatch, jerk, push press, pulls, bench throws, and their variations, squats, deadlifts, and plyometric exercises (Baker, 2002). This response to these exercises by the body transfers into athletic ability and explosive movement, as these are multi-joint movements that work major muscle groups in unison, and are important when developing success of athletic ability (Argus, et al., 2011; Cormie, McGuigan, & Newton, 2011; Stone et al., 2006). In an analysis comparing the variations of the power clean, Comfort, Allen, and Graham-Smith (2011) found that the power clean and the power pull from the mid-thigh acquired higher peak power output, higher rate of force development, and peak vertical ground reaction forces when compared to the power clean from the floor and the hang power clean. These exercises are suggested to be very important in the development of athletic performance and have the most crossovers into the sport realm (Comfort, 2013). According to Hansen, Cronin, Pickering, & Newton (2011), training prescription for the elite rugby player is a complex task for the strength coach. The researchers further stated that programing training sessions must take into consideration of factors such as the long seasons of match play, the nature of rugby as a collision sports and the demands of training such as speed, strength, skill development, aerobic and anaerobic conditioning, and team practices. Hansen et al. (2011) went on to study the effect of cluster loading versus traditional straight sets during rugby preseason training. Hansen et al. found that
both groups elicited increases in maximum strength but traditional set training increased maximum strength more so than the cluster-training group. Further reported by Hansen et al. was that cluster training increased the jump squat power and velocity more so than the traditional sets group, although it was only moderate.

In a study comparing Olympic weightlifting (OWL), plyometric training, and traditional resistance training (RT) in male children (10-12 years) who trained in judo and wrestling, Chaouachi et al. (2014) used a 12-week training program for each group with the same volume levels and same number of multi-joint exercises. This program was periodized throughout the 12 weeks of training with altering sets and repetitions with two mesocycles each consisting of six weeks. The researchers found that OWL elicited better performance adaptations in the countermovement jump (CMJ), horizontal jump, 5- and 20-meter sprint times than plyometric training and had a considerable advantage over resistance training in balance, isokinetic power variables, and rate of force development (RFD). RFD requires a strong balance capability and OWL are explosive exercises that imitate athletic actions that demand coordination and stability. Training volume for pre-season is best at 4-5 set of 7-9 reps at 77-83% 1RM and 3-4 training sessions a week or depending on the proximity to match play, during in-season training should be set at 3-5 sets and 3-5 reps with intensity at 70-90% 1RM (Gamble, 2004; McMaster et al., 2013).

Strength Demands

Strength is the ability to exert a force against an object (Stone, Sands, Pierce, Newton, Haff, & Carlock, 2006). Considering the demands of the sport of rugby, the rugby player requires effective displays of strength (Gabbett, King, & Jenkins, 2008).
Strength, specifically leg strength, facilitates stronger leg drive, which is important to have in order to tackle and breaks tackles throughout the match (Baker & Newton, 2008; Gabbett, 2006). Producing the force required for success in contact sports such as rugby places a demand on the athlete to possess high levels of maximum strength (Argus, Gill, & Keogh, 2012; Sporis, Jovanovic, Krakan, & Fiorentini, 2011). Baker (2002) stated that strength and power levels can clearly distinguish the level at which a rugby player is at and therefore increases in strength and power should be the goal for every player desiring to go onto the next level of play. In addition to the previous mentioned Olympic weightlifting exercises, lifts such as the squat, bench press, pull-up, row, deadlift, straight leg deadlift, shoulder press, and their variations are primarily used to develop strength (Baker, 2002). These lifts can be loaded with very heavy weights to elicit a response in the body to gain muscle density and strengthen the muscles that are essential to producing force. Pre-season strength is developed by resistance training with weights and volumes of strength training trend towards 3-6 sets and 3-8 reps with intensity at 70-98% 1 RM (Argus et al., 2010; Gamble, 2004; Gabbett, 2006; McMaster, Gill, Cronin, & McGuigan, 2013). Periodization is used where volume is increased and intensity is decreased in beginning phases of training and it shifts to low volume with high intensity in later phases. Four days a week of training was the most productive training regimen with 5 days a week being used in early phases where an undulating periodization was in place (Argus et al., 2010; Baker, 2002; Gamble, 2004; Gabbett, 2006).

Comfort, Stewart, Bloom, and Clarkson (2013) found that the development of squat strength enhanced the performance of the vertical jump and 5-meter sprint times of
male soccer players (17.2 ± 0.6 years) when compared to absolute squat strength, and found that relative strength correlated the strongest with 20-meter sprint times. In addition, Comfort, Haigh, & Matthews (2012) found that increased maximum strength correlated with increases in 5-m, 10-m, and 20-m sprint times and stated that increasing strength during preseason should be prioritized and that the focus should then shift to development of power and maintenance of strength during the competitive season. When studying elite male rugby players from England, Comfort, Graham-Smith, Matthews, and Bamber (2011) also found that using relative measures instead of absolute measures when comparing performance in power and strength could be a better indicator of sports performance.

During the competitive phase of sports it is important to maintain what the athlete has developed during off- and preseason training in order to have a clear advantage over the opposition. In-season strength and conditioning programs are carefully designed to ensure the athlete’s performance is maintained or improved (Hansen et al., 2011). Marques, Van Den Tillaar, Vescovi, and Gonzalez-Badillo (2008) found that they were able to increase in-season performance in both strength (parallel squat +11.8%, bench press +15%) and power (unloaded and loaded countermovement jumps +3.8% to 11.2%, respectively) using a well-designed resistance and plyometric training program for elite female volleyball players (N=10).

The contact and collision inherent in the sport of rugby requires that athletes combine power, strength, speed, endurance, and agility (Frounfelter, 2008). Frounfelter (2008) studied the incidences of neck injuries rugby and highlighted the need for the
building of strength for the neck and shoulders for injury prevention. Strength training and increases in overall body strength also impacts aerobic and anaerobic power, which is also a key factor in rugby. According to Sporis et al. (2011), 12-weeks of strength training during the last phase of preseason for elite level women soccer players increased their strength (2.7 to 10.7%) and also resulted in improvement of their aerobic power (+4.3%) and anaerobic power (+2.8%).

Plyometric Training Considerations

Plyometric training is high in intensity, allows for the delivery of strength by the muscles in a short amount of time, helps in developing power, and is useful for athletes who rely on dynamic explosiveness in their respective sport (Asadi, 2013; Ozbar, Ates, & Agopyan, 2014; Beneka et al., 2013; Chelly, Hermassi, Aouadi, and Shepard, 2014; Chu, 1998; Holcomb, Lander, Rutland, & Wilson, 1996; Pienaar & Coetzee, 2013).

Plyometric training is known as exercises that link the strength of an athlete with speed to produce power (Chu, 1998; Hedrick, 2008).

Rugby players need power to conduct the rigors of tackling, mauling, scrumming, jumping, and change of directions (Pienaar & Coetzee, 2013). Pienaar and Coetzee (2013) found that a combined conditioning and plyometric training regimen increased speed, increased anaerobic power, and increased agility for collegiate rugby players (18-19 years of age) in a four week study where they performed 2 sets of 10 repetitions of each plyometric exercise for 3 sessions a week along with 3 days a week of regular rugby conditioning and resistance training. Similar to Pienaar and Coetzee, Chaouachi et al. (2014) found similar results with plyometric and resistance training but also used
Olympic weightlifting. According to Chaouachi et al. (2014), plyometric training participants performed better than the resistance training participants in the tests for balance, peak torque at 60° and 300°x s-1, mean power at 300°xs-1, and had similar results of the resistance training group in countermovement jump and horizontal jump. Plyometrics, like Olympic weightlifting, also demands high rates of force development and are beneficial to power production. The study concluded that resistance training should be combined with Olympic weightlifting and plyometric training in order to increase power, balance, and coordination. Combined training is also recommended by Hedrick (2008) to elicit increases in vertical jump performance of women volleyball players and it is important to select plyometric exercises that are sport specific.

Ozbar, Ates, and Agopyan (2014) investigated the use of plyometrics in consideration of leg power, sprint, and jump performance for women soccer players. Their findings concluded that plyometric training improved 20-m sprint times, and increased the performance the standing broad jump distance, countermovement jump height, triple hop distance, and peak power. The study by Ozbar et al. took place once a week for 8 weeks while the soccer players were in their competitive phase and the researchers concluded that although the training was once a week it would be suitable to conduct their training twice a week. Asadi (2013) found that in basketball players an in-season plyometric training program, consisting of 2 days a week for 6 weeks and with 3 sets of 15 repetitions significantly improved their speed and improved their balance versus the control group that just performed the tactical and technical practices of a regular basketball season. Asadi suggests that plyometrics should be used during the
competitive phase as preseasons can be short and the use of these exercises improve
performance which is one of the many goals of coaches. Chelly, Hermassi, Aouadi, and
Shepard (2014) also studied the in-season effects of plyometric training for sport but
focused on elite adolescent handball players (ages: 17.4 ± 0.5). The researchers used
exercises for both the lower and upper body and found that they improved the peak
power for both lower and upper body and were able to accomplish this with 2 training
sessions a week. Chelly et al. also suggested the use of a plyometric program during
season play, as it is easy to implement and is shown to improve power and does not
interfere with other performance considerations like speed.

Recovery from plyometric training is a factor for the strength coach or trainer to
take into consideration. Beneka et al. (2013) found that it is best to allow for 72 hours of
recovery before more plyometric training is commenced and that plyometric training
should be combined with strength training. The authors further stated that the more that
training is combined and adaptations occur, the shorter the recovery time gets. Chelly et
al. (2014) had significant results in their study and also allowed for 72 hours between
training sessions for their experiment group. In addition to the topic of recovery, Tobin
and Delahunt (2014) suggested that only when fatigue from a heavy stimulus has
subsided does an improvement in performance become evident. Tobin and Delahunt
studied production of a post-activation potentiation effect within the same session. Post-
activation potentiation is the increase in motor performance in response to a conditioning
stimulus (Tobin & Delahunt, 2014). They measured performance at 1 minute rest, 3
minutes rest, and 5 minutes rest. Eighteen of the 20 participants, who were rugby
players, experienced an increase in the countermovement jump after 1-minute rest with the total numbers of participants declining in improvement with the 3 and 5 minutes rest and performance of the jumps. Participants also experienced increase in peak force for the jumps of all rest periods. The researchers concluded that plyometric training in repeated series can take advantage of post-activation potentiation and strength and conditioning personnel should program plyometric exercises in a series of repeated jumps.

Olympic Weightlifting Considerations

Olympic weightlifting is a key component of strength and conditioning for sport performance of such movements as jumping and sprinting (Chaouachi et al., 2014; Comfort, 2013; Cormie, McGuigan, & Newton, 2011; Gamble 2004). Olympic weightlifting is also considered safe and effective for adolescents when given proper instructions and loads (Chaouachi et al., 2014; Faigenbaum et al., 2009). Exercises such as the clean variations, snatch variations, and jerk variations are often included into power training programs for athletes (Chaouachi et al., 2014; Cormie, McGuigan, & Newton, 2011). These exercises are high in force and high in velocity and large power outputs can be produced over a wide range of loading conditions (Cormie, McGuigan, & Newton, 2011). In an off-season training program for NCAA Division III football players, Hoffman, Cooper, Wendell, and Kang (2004) combined Olympic weightlifting training with power (strength) training and found that the combination of the two styles performed better in post-test versus only the power training group. This study showed moderate correlations between the Olympic group and performance increases in the tests
of the vertical jump, 40-m sprint, and 1RM back squat. Marshall (2005) recommended combining Olympic and power/strength training during in-season for rugby players. In Marshall’s overview of his strength and conditioning program for rugby union players, he programmed Olympic lifts combined with power/strength lifts for 1-2 days a week with a third day of just power/strength training.

In-season Olympic-lifts are recommended to be completed at a volume of high intensities and low reps; Gamble (2004) suggests preseason 3-5 sets and 3-5 reps depending on the load with intensities of 70-90% 1RM and in-season considerations for power lifts are conducted two times a week at greater that 80% 1RM intensity for 3-4 reps and 2-3 sets. This training volume helps maintain the gains in power as the demands of the season limit resistance training sessions (Gamble, 2004). Similar to Gamble (2004), McMaster et al. (2013) stated in their review of training procedures that in-season programs that want to maintain consistent power performance in their athletes should utilize training that consists of 1-2 days a week, 3-5 sets of 4-6 reps at 75-85% 1RM. Baker (1998) stated that 3 sets for power (Olympic) exercises are to be used and a repetition range of 1-5 per set with fewer reps in that range is being used for higher intensities. This is to prevent fatigue and ensure an explosive execution of the lifts (Baker, 1998).

Speed and Endurance Demands

Not only are power, strength, and agility needed for rugby, but speed and endurance are both important too. Rugby league and union matches last anywhere from 60-80 minutes, plus additional play for penalties, and adolescents 14-18 years old were
shown to run as few as $2,208 \pm 637$ m to $3,576 \pm 956$ m per training session depending on their level of play (Hartwig, Naughton, & Searl, 2008). Cunniffe, Proctor, Baker, & Davies (2009) showed that to upwards of an average of $6,953$ m is ran by elite level rugby league players. Gamble (2004) and Gabbett (2006) both stated that field conditioning drills and conditioning games could increase endurance. This is very specific to the game where players practice how they play. No other drills are better than this type of training as it brings out the same aerobic endurance demands that the players will need for a match (Gabbet, 2006a, 2006b). Interval and sprint training was also shown to produce a speed-endurance affect that is similar to the constant intermittent activity of the game (Iaia & Bangsbo, 2010). Training loads and volumes for endurance workouts should be similar to that of match length and should use periodization for increases of volume as the season nears. According to Cunniffe et al. (2009), 10% of an elite game studied was spent performing intense running bouts. The sport of rugby demands speed in order to quickly maneuver one’s self into position for the attack or defense (Gabbett, 2006). Cunniffe et al. also found that usual sprint distances were 15-20 m with occasions of 40 m, with speeds over 20 km/h, showing the demand for rugby players to accelerate quickly. Cronin and Hansen (2005) state that the speed and quickness of the first steps and the acceleration abilities of athletes is of great importance and has advantages in multiple sports.

Increasing speed and endurance is important to accomplish during preseason training and is done so with effective programming (Argus, Gill, Keogh, Hopkins, & Beaven, 2010). It is the goal of the strength and conditioning coach to maintain, or
possibly increase these variables during an in-season training program (Comfort, Haigh, & Matthews, 2012). Mujika, Santisteban, and Castagna (2009) found that contrast/complex training programs of alternating heavy and light resistance training days combined with soccer specific drills increased sprint times of 15-m tests in elite junior (18.3 ± 0.6 years) soccer players during the competition phase of play.

Testing Considerations

Other than developing and implementing the training program, the strength and conditioning coach must have tools to use to measure the outcomes of their programs. These are important measures to have in order to check the effectiveness of one’s program. Because of the nature of the game of rugby, with its continuous play, collisions, and mixture of aerobic and anaerobic energy pathways being used, the condition testing is hard to replicate (Atkins, 2006). Where 1 RM or 3 RM testing is easily done for strength testing, performance of rugby players as it relates to the game has less clear standards. Other tests are widely known and used like standing broad jump, vertical jump measures, sprint speed, agility, body weight and weighted countermovement jumps, drop/depth jump height, ballistic bench throws, and anthropometric measures (Bevan et al., 2010; Cronin & Hansen, 2005).

Selecting tests to use should be specific to the athletic capabilities that the coach is trying to improve and should be used to further the preparation and performance of the athlete (McGuigan, Cormack, & Gill, 2013). In a survey of 38 high school strength and conditioning coaches, Duehring, Feldman, and Ebben (2009) 33 of 38 coaches reported maximal muscular strength testing with their athletes using a variety of
lifts, which included the bench press, squat, clean, and deadlift. Though the total number (n=38) of coaches surveyed is low in comparison to actual practicing coaches at this level, surprisingly only two coaches reported using the 1RM. The practice of 1RM has been shown to be safe when administered correctly to youth and adolescents (Behm et al., 2008; Faigenbaum et al., 2009; Faigenbaum & Myer, 2009). Of the major lifts for strength the most widely used for testing purposes are the back squat, bench chest press, deadlift, and pull-up test. The pull-up test is a maximal repetition test that sees how many pull-ups one can do.

Speed is tested for rugby specifically by timing sprint speed of the 5-, 10-, 20-, and 40-meter sprint times (Gabbett, 2006). Agility is tested by many different tests like the L run using dual-beamed electronic timing gates (Coutts, Murphy, & Dascombe, 2004; Gabbett, 2006; Gabbett & Domrow, 2012), the T-test, Hexagon test, and the change of direction Illinois Agility Test (Hachana et al, 2013). These tests were the most commonly used in the studies and are important to have in a coach’s repertoire to see if the program is decreasing the speed and agility times. All these measures are readily available to be put to use and seem to be the most cost-efficient.

Vertical jump (squat jump) measures are taken primarily by using a Vertec jumping device where jump height is assessed by the displacing of extended plastic veins during the participants jump and reach (Coburn, 2012). The vertical jump measures leg muscular power and is used by many investigators (Gabbett, King, & Jenkins, 2008). This test recommends 3 trials with the best of them being recorded. This too is a valid and reliable tool for any of its users. This test is a good measure of muscular power.
production. Past studies have used the Vertec device and used the scores for correlations to power (Coutts, Murphy, & Dascombe, 2004; Gabbett, 2006).

Testing can show the coach where to improve on each player and how to make is program better (McGuigan, Cormack, & Gill, 2013). The coach should choose tests that are familiar and practiced with as much background in the procedures available so the testing is done correctly. Also time considerations and practicality of testing facility, like a strength and conditioning weight room, tests can be more field expedient and also provide the coach with good reliability (White, 2008). Availability of equipment and access to technology can make testing difficult or easy for the tester. If the technology that is relied on for testing purposes is not available, there are still ways to test for strength and power without the expensive equipment (McGuigan, Cormack, & Gill, 2013).

Conclusion

Rugby is a very complex sport when one considers the training that takes place in order to be in the best condition for the match. The strength and conditioning coach has to consider the nature of the game when programming a strength and conditioning program. To do this effectively the coach needs to emphasize endurance, strength, and power, and then needs to be able to test to see how effective the program was. Previous studies showed that the use of two days a week while in a competitive season was useful in maintaining performance where volumes of 3-5 sets of 1-10 reps were used (Baker, 1998, Duehring, Feldman, & Ebben, 2009; Hoffman & Kang, 2003; Marques, Van Den Tillaar, Vescovi, & Gonzalez-Badillo, 2008; Mujika, Santisteban, & Castagna, 2009; Schneider,
Arnold, Martin, Bell, & Crocker, 1998). Many of these studies have been conducted on professional rugby players or on other sports. The purpose of this study was to examine the effects of an in-season 6-week Olympic/resistance training program versus a 6-week in-season plyometric/resistance training program in collegiate club rugby players.
Chapter 3

METHODOLOGY

The purpose of this study was to examine the effects of a 6-week in-season Olympic/resistance training program versus a 6-week in-season plyometric/resistance training program in collegiate club rugby players during the competitive phase of their season.

Participants

Participants for this study were recruited from a men’s collegiate club rugby team (N=31). The investigator obtained approval from the coaches and players of the team to have them participate during the days when there were no practices scheduled and the players signed the Consent to Participate Form that was approved by Sacramento State Institutional Review Board (Appendix B). Players were also given a Physical Activity Readiness Questionnaire (PAR-Q) (Appendix C) and a Demographic and Athletic Background Questionnaire (Appendix D) that was reviewed by the researcher. Only male athletes approximately between the ages of 18 and 25 were studied for this investigation. The testing and treatments were programmed around the in-season of the rugby club with regards to their practice schedule and match schedule.

To be included in the study, participants had to be practicing and playing in the matches, injury free, and willing to be at the specified workout time two times a week for 9 weeks.
Measures/Instruments

Before all any further data collection happened, all participants participated in an introduction to the exercises being tested to become familiar with the structure and procedures. The athletes were then put through a dynamic warm up that consisted of a 1 minute jog, hip and shoulder mobility movements, and traveling dynamic stretching movements. This warm up lasted no more than 12 minutes.

Vertical Jump testing was performed first. A Vertec (Sports Imports, Columbus, OH) device was used to measure vertical jump. The Vertec was placed in the weight room on flat ground and participants were given verbal instructions on how to perform the vertical jump test by the strength coach. The standing reach was taken by having each participant walk under a lower setting of the Vertec with their dominant arm raised and the measure taken at the point where the middle finger hit the highest measuring vane. The Vertec was then adjusted for the height of the individual participant’s proximal jump height so that they would not miss the vanes. Participants stood a ½-foot away from the Vertec and performed a maximal vertical jump with a countermovement. As the jumper reached peak height they extended their arm to displace the measuring vanes of the Vertec. Each vane measures a half-inch and therefore the vertical jump height was measured to the half inch. Each participant was allowed as many jumps until failure to reach a vane. They will have 30 seconds between attempts. The Vertec jump height was measured by taking the difference of the standing reach and the vertical jump reach.

Using a 300-foot measuring tape, taped to the ground using athletic tape, the researcher tested the Standing Broad Jump. A total of 15 feet of the measuring tape was
secured to the ground with athletic tape every three feet. Participants were warmed up with dynamic stretching and verbally instructed by the strength and conditioning coach on how to perform the broad jump. Participants were instructed to stand with their toes to the athletic tape where the measuring tape was secured at the zero line. Allowing a countermovement the participants leaped forward as far as they could. The distance was taken by placing a wood dowel inline with the back heal of where the participant landed at 90 degrees of the measuring tape. The participants had three attempts at their best broad jump with 30 seconds of rest between trials.

The sprinting speed of the participants was evaluated at 40-m distances using dual-beam electronic timing gates (Brower Timing Systems). The test took place on a marked football field and 40-meters was measured with a 100-meter measuring tape. The starting sensor was placed on the ground at the starting line and the sensor gates were positioned at the 40-m line at the finish. Athletes were instructed to start in a three-point stance with one hand on the sensor and to run as fast as they could between the timing gates at the finish line. Times were measured to the nearest 0.01 second with the faster of two trials being recorded.

Procedures/Data Collection

This study was approved by the Institutional Review Board at Sacramento State University. The investigator obtained written consent to participate from all participants involved (Appendix B). Those participants who met the criteria for participation were asked to be involved in the study. The participants were asked to complete two days of Olympic/resistance weight training or Plyometric/resistance training a week in addition to
their in-season practices and matches. Each training session was coached and observed by a NSCA Certified Strength and Conditioning Specialist who was also a Level 1 Performance Coach certified by the United States Weightlifting Association. A similar program was adapted from the Baker (1998) paper of wavelike periodization for in-season rugby and American football. This study lasted for a total of 9-week with the first week being an introductory phase, the second week for pre-testing, weeks 3-8 for completing the training programs, and the ninth week for post-testing. The pre-tests and post-tests took place in Sacramento State’s Solano Hall 1020 and the practice athletic field. In Solano Hall 1020, there were seven squat racks and eight freestanding racks with Olympic lifting platforms. The gym was equipped with Olympic lifting bars, bumper plates, dumbbells, and metal plates.

Before completing the pre-testing the participants were asked to have a full day’s recovery prior to the test day. Participants were tested together regardless of group assignment. The strength coach gave participants a dynamic warm up for 10 minutes. Participants were familiarized with the vertical jump, standing broad jump, and the 40-m sprint prior to attempting the tests by the strength coach. The tests were given in the before mentioned order and were the same for all participants (Baechle & Earle, 2008).

After the testing, the participants were randomly divided up into two even groups. Special attention was given in separating players equally with regards to their rugby position. There were the same number of A-side players and B-side players in each group with the same number of backs and forwards in each group. The group was given a one-session introduction training that taught the athletes the techniques of the either the
Olympic lifts or Plyometric exercises, and all participants had the same training for the base program of resistance exercises. There were a total of two training sessions for this week and the athletes were instructed only using the barbell for practice. After the two weeks the participants started their Olympic/resistance training program or Plyometric/resistance program. Intensity consisted of what each individual player’s estimated weight that could be lifted for completion of the repetitions, as Baker (1998) stated. Volume was set at 12-25 reps per exercise, broken into 4 sets per exercise, the first set being a warm up, for 5-6 exercises per session. Each session lasted for approximately 1 hour and players lifted on Monday and Wednesday mornings. At the end of the 6-week training period the participants were re-tested on the ninth week. All procedures were the same as in the pre-tests.

The entire participant’s testing information was kept on Excel spreadsheets and their names were correlated with an identifying number as to keep their information private. A master list was kept separate from the data that identified the name with the corresponding identification number.

Data Analysis

All statistical analysis was conducted using SPSS for Mac version 22. A paired t-test was used to analyze with-in group comparisons. Alpha level was set at $P < 0.05$. An independent $t$-test was used for comparing the difference between the two groups. Data was also reported as means $\pm$ SD.
Chapter 4

RESULTS

The purpose of this study was to examine the effects of an in-season 6-week Olympic/resistance training program versus a 6-week in-season plyometric/resistance training program in collegiate club rugby players during the competitive phase of their season. The initial pre-tests were conducted in January, one week before the rugby teams first regular season match. There were a total of 31 participants involved in the pre-tests, 17 players in the Olympic/resistance training group and 14 players in the Plyometric/resistance training groups. Scheduling conflicts with the participants’ class and work schedules caused the groups to be uneven. Both training programs lasted 6 weeks and all active practicing and playing players were asked to participate. The post-tests took place in March with just under half of the matches still to be played. Only those participants who completed at least 85 percent of the training program were included in the final testing and statistical analysis. Due to injuries that happened during matches and dropouts, 24 players completed the post-tests, 13 players from the Olympic/resistance training group and 11 players from the Plyometric/resistance training group. Due to inclement weather, the sprint post-test had to be retested the following week after the post-tests were suppose to take place.

Within Groups Comparisons

Vertical Jump

In the Olympic/resistance group (N=13), the athletes averaged a vertical jump height of 23.73 inches (SD ± 6.2) in the pre-test and averaged 23.57 inches (SD ± 3.28)
in the post-test. The paired *t* test analysis indicated no significant difference (*P* < 0.05) in the vertical jump performance from the pre-test to the post-test (*t* = 0.170, *p* = 0.9, df = 12, SD ± 3.26).

In the Plyometric/resistance group (N=11), the athletes averaged a vertical jump height of 21.45 inches (SD ± 5.28) in the pre-test and averaged 22.36 inches (SD ± 4.43) in the post-test. The paired *t* test analysis indicated no significant difference (*P* < 0.05) in the vertical jump performance from the pre-test to the post-test (*t* = .220, *p* = 0.22 df = 10, SD ± 2.34).

Figure 1. Olympic and Resistance Group’s Vertical Jump Pre- and Post-Test Results
Broad Jump

In the Olympic/resistance group (N=13), the athletes averaged a horizontal distance of 91.26 (SD ± 10.29) inches in the pre-test and 91.28 inches (SD ± 10.20) in the post-test. The paired $t$ test analysis indicated no significant difference ($P < 0.05$) in the broad jump from the pre-test to the post-test ($t = -0.011, p = 0.67, df = 12, SD = 6.04$).

In the Plyometric/resistance group (N=11), the athletes averaged a horizontal distance of 87.64 inches (SD ± 11.61) in the pre-test and averaged 89.00 inches (SD ± 11.58) in the post-test. The paired $t$ test analysis indicated no significant difference ($P < 0.05$) in the broad jump performance from the pre-test to the post-test ($t = -1.347, p = 0.21, df = 10, SD = 3.36$).

Figure 2. Olympic and Resistance Group’s Broad Jump Pre- and Post-Test Results
40-Meter Sprint

In the Olympic/resistance group (N=13), the athletes averaged a sprint time of 5.99 seconds (SD ± 0.5) in the pre-test and 5.86 seconds (SD ± 0.4) in the post-test. The paired *t* test analysis indicated a significant difference (P < 0.05) in the 40-meter sprint from the pre-test to the post-test (*t* = 3.425, *p* = 0.01, df = 12, SD ± 0.1).

In the Plyometric/resistance group (N=11), the athletes averaged a sprint time of 6.18 seconds (SD ± 0.45) in the pre-test and 6.03 (SD ± 0.41) seconds in the post-test. The paired *t* test analysis indicated a significant difference (P < 0.05) in the 40-meter sprint performance from the pre-test to the post-test (*t* = 2.923, *p* = 0.02, df = 10, SD ± 0.17).

![Figure 3. Olympic and Resistance Group’s 40-Meter Sprint Pre- and Post-Test Results](image-url)
Between Groups Comparisons

Vertical Jump

In the vertical jump pre-tests the Olympic/resistance group scored a mean of 23.73 inches (SD ± 6.20) and the Plyometric/resistance group scored a mean of 21.45 inches (SD ± 5.28). The independent t test indicated no significant difference (P < 0.05) between the pre-tests (t = .459, p = 0.34, and df = 22, SD ± 6.19). In the post-tests of the vertical jump the Olympic/resistance group scored a mean of 23.57 inches (SD ± 3.28) and the Plyometric/resistance group scored a mean of 22.36 inches (SD ± 4.43). The independent t test indicated no significant difference (P < 0.05) between the post-tests (t = .769, p = 0.46, and df = 22, SD ± 3.81).

Broad Jump

In the broad jump pre-tests the Olympic/resistance group scored a mean of 91.26 inches (SD ± 10.29) and the Plyometric/resistance group scored a mean of 87.64 inches (SD ± 11.61). The independent t test indicated no significant difference (P < 0.05) between the pre-tests (t = .813, p = 0.43, and df = 22, SD ± 10.82). In the post-tests of the broad jump the Olympic/resistance group scored a mean of 91.28 inches (SD ± 10.20) and the Plyometric/resistance group scored a mean of 89.00 inches (SD ± 11.58). The independent t test indicated no significant difference (P < 0.05) between the post-tests (t = .515, p = 0.62, and df = 22, SD ± 10.67).
40-Meter Sprint

In the 40-meter sprint pre-tests the Olympic/resistance group scored a mean of 5.99 seconds (SD ± 0.5) and the Plyometric/resistance group scored a mean of 6.18 seconds (SD ± 0.45). The independent t test indicated no significant difference (P < 0.05) between the pre-tests (t = -.985, p = 0.34, and df = 22, SD ± 0.45). In the post-tests of the 40-meter sprint the Olympic/resistance group scored a mean of 5.86 seconds (SD ± 0.4) and the Plyometric/resistance group scored a mean of 6.03 seconds (SD ± 0.41). The independent t test indicated no significant difference (P < 0.05) between the post-tests (t = -1.017, p = 0.32 and df = 22, SD ± 0.40).

Hypotheses

1. There will be no statistically significant difference with-in the vertical jump scores of the two groups was supported by the data analysis. The null hypothesis was accepted. The researcher found that there was no statistical significance with-in the Olympic/resistance group or with-in the Plyometric/resistance group from pre- to post-tests.

2. There will be no statistically significant difference between the vertical jump scores of the two groups was supported by the data analysis. The null hypothesis was accepted. The researcher found that there was no statistical significance between the Olympic/resistance group and the Plyometric/resistance groups from pre- to post-tests.

3. There will be no statistically significant difference with-in the broad jump scores of the two groups was supported by the data analysis. The null hypothesis was
accepted. The researcher found that there was no statistical significance within the Olympic/resistance group or within the Plyometric/resistance group from pre- to post-tests.

4. There will be no statistically significant difference between the broad jump scores of the two groups was supported by the data analysis. The null hypothesis was accepted. The researcher found that there was no statistical significance between the Olympic/resistance group and the Plyometric/resistance group from pre- to post-tests and there were also no significant differences between the two groups from pre- to post-tests.

5. There will be no statistically significant difference within the 40-meter sprint times of the two groups was not supported by the data analysis. The null hypothesis was rejected. The researcher found that there was a statistical significant difference within the Olympic/resistance group and there was a statistical significant difference within the Plyometric/resistance group from pre- to post-tests.

6. There will be no statistically significant difference between the 40-meter sprint times of the two groups was supported by the data analysis. The null hypothesis was accepted. The researcher found that there was no statistical significant difference between the Olympic/resistance group and the Plyometric/resistance group from pre- to post-tests as both groups similarly improved their speed.
Summary

There was no significant improvement in performance in the vertical jump and broad jump for both groups. These results confirm the null hypotheses for these two tests. Both groups improved in their 40-meter sprint times. These results reject the null hypothesis that there would be no statistically significant difference within each group from pre-test to post-test. There was no statistically significant difference between the two groups. The null hypothesis that there would be no significant difference between the groups was confirmed.
Chapter 5
DISCUSSION

The purpose of this study was to examine the effects of an in-season 6-week Olympic/resistance training program versus a 6-week in-season plyometric/resistance training program in collegiate club rugby players during the competitive phase of their season. The rugby team that participated in the study was split up into two groups, an Olympic weight training group with resisted strength exercises and a Plyometric jump group with resisted strength training exercises. Prior to the start of the 6-week training program all participants were tested in the vertical jump, broad jump, and 40-meter sprint. Both groups trained in their respective groups two times a week for 6-weeks on Monday and Wednesday mornings for an hour each session. Each group had the same resistance training exercises with the addition of their respective group’s specialized lifts. This program used a periodized wavelike progression of set, reps, and intensities that were shown to be successful in professional rugby players developed by Baker (1998). The Olympic weightlifting group performed the hang clean and snatch pull during the first workout of the week and the power clean and clean pull on the second. The Plyometric jump group performed the jump squat and tuck jump on the first workout of the week and the box jump and hurdle jump on the second. Both groups participated in the same team practices two days a week on Tuesday and Thursday evenings. Matches were played on Saturdays. Fridays and Sundays were rest and recovery days. At the end of the 6-week training program, the participants were re-tested in the vertical jump, broad
jump, and 40-meter sprint. The researcher was at every workout to coach and monitor the lifts for form, technique, and safety.

Results from previous studies have shown that an in-season training program for maintaining strength, speed, and power is vital to the performance of an athlete (Argus, Gill, Keogh, Hopkins, & Beaven, 2009, Baker, 1998; Baker & Newton, 2008; Comfort, 2013; Comfort, Graham-Smith, Matthews, & Bamber, 2011; Gabbett, King, & Jenkins, 2008; Hansen et al., 2011; Marshall, 2005). Studies conducted specifically during the competitive season of sports have shown to produce increases of the performance variables such as sprints, broad jumps, strength, countermovement jumps, and the vertical jump (Baker, 2001; Chelly, Hermassi, Aouadi, and Shepard, 2014; Gamble, 2004; Hoffman and Kang, 2003; Marques, Van Den Tillaar, Vescovi, and Gonzalez-Badillo, 2008; McMaster et al., 2013; Ozbar, Ates, and Agopyan, 2014; Pienaar & Coetzee, 2013; Sporis et al., 2011). In contrast with these findings of the previous mentioned studies, there are instances of decreases in performance over a competition phase in rugby players. Argus et al. (2009) found that as there were some small decreases in lower body strength and maintenance of upper body strength, the lower and upper body power mean did decrease over a 13-week period. Supporting detraining while in-season, Schneider, Arnold, Martin, Bell, and Crocker (1998) tested collegiate football players in the bench press, broad jump, vertical jump, and 20-yard shuttle run and found a decrease in performance in the vertical jump, bench press, and broad jump. The athletes studied participated in a 2-days per week weight training during season.
Vertical Jump

In the vertical jump, the Olympic/resistance and the Plyometric/resistance group showed no statistical significant difference in their performance after the 6-week training program. Statistically the results confirm the null hypothesis that neither within nor between groups’ differences changed, although the vertical jump of the Plyometric group did increase by 0.91 inches and the Olympic group went down 0.1 inches. The increase of the Plyometric/resistance group may lend to the specificity principle of training that jump training more than likely improves jump performance (King & Cipriani, 2010). Previous studies of training in-season suggest the goal is to maintain the performance levels of the athletes, prevent injury, and possibly increase performance (Argus, Gill, Keogh, Hopkins, & Beaven, 2009; Hedrick, 2005; Marshall, 2005; McMaster, Gill, Cronin, & McGuigan, 2013; Wrigley, Drust, Stratton, Scott, & Gregson, 2012). The results of vertical jump in this study would agree with data of Baker’s (2001) comparison study supporting maintenance in lower body mean power in college-aged rugby players over a 19-week (college-aged) and 29-week period (professional).

Broad Jump

In the broad jump, the Olympic/resistance and the Plyometric/resistance group showed no statistical significant difference in their performance after the 6-week training program. These results statistically confirm the null hypothesis that neither within nor between group differences changed, although the broad jump of the Plyometric group did increase by a mean of 1.36 inches and the Olympic group mean essentially stayed the same. The increase in the Plyometric group, even though it was not statistically different,
may show that it is possible to maintain or slightly improve performance levels in the broad jump during a competitive season of collegiate club rugby which agreed with the results in studies done in multiple sports (Chelly, Hermassi, Aouadi, & Shepard, 2014; Chu, 1998; Holcomb, Lander, Rutland, & Wilson, 1996; Pienaar & Coetzee, 2013). It seems that the present study was not able to elicit a statistical significance of results as found in Argus, Gill, Keogh, McGuigan, and Hopkins (2012) who showed an increase (3.6 cm) in the broad jump in rugby players during their season.

40-Meter Sprint

In the 40-meter sprint the analysis showed a statistical significant change from pre- to post-test for both groups. The Plyometric group showed a greater decrease in sprint time means running 0.15 seconds faster than their pre-test. The Olympic group ran a mean of 0.13 seconds faster than their pre-test. Similarly, previous studies showed sprint times were also found to improve by the use of plyometric training by Asadi (2013) in basketball in-season training and by Ozbar, Ates, and Agopyan (2014) in soccer players during their competitive season. Comfort, Haigh, and Matthews (2012), concluded that pre-season increases in leg strength via the back squat improved sprint performance. The fact that the current rugby team studied participated in two days of lifting; back squating one day and front squatting the other may be a factor in the change in speed for both the Plyometric and Olympic groups. The between groups analysis showed no statistical significant difference confirming the between group null hypothesis for the 40-meter sprint. Each group improved but one was not shown to be better than the other statistically. More importantly the participants did not decline in performance.
The researcher speculates that a team could run either of the two programs to improve 40-meter sprint times.

Recommendations for Future Studies

The American collegiate rugby population is under studied and under supported. Most rugby studies take place in Australia, New Zealand, and Europe using professional clubs and organizations (Baker, 1998, 2001; Baker and Newton, 2008; Bevan et al., 2010; Comfort et al., 2011; Coutts, Murphy and Dascombe, 2004; Cronin and Hansen, 2005; Hori et al., 2008). The researcher recommends studying more collegiate club players for the development of club rugby in the United States. The current study took place during season but was limited by the time available with the players prior to their season. The number of participants also limited this study and it is the researchers recommendation that more participants be used in future studies. Further research should be conducted on this population for off- and pre-season strength and conditioning. Researching the effects of such training and the carryover into the competitive season would be the next step to see what would be best utilized at club levels. Repetition maximums should also be tested in future studies. This study was unable to conduct RM’s of the participants because of the proximity to the start of the season. Many clubs are left to train on their own and are in need of support in strength and conditioning. A well-outlined and researched yearly strength and conditioning program can help support collegiate teams in the United States.

This study looked at the comparison of a strength-training program with the addition of Olympic weightlifting versus Plyometric jumps during in-season of collegiate
rugby. The next step for future research could be to combine Olympic and Plyometric training along with strength training and compare to a group performing just one of the studied programs. Other research could also conduct a comparison study that includes a control group of just strength-resistance training program group with an Olympic weightlifting program group and a Plyometric training group.

Conclusion

The overall training effects of an in-season program are overwhelmingly positive for athletes competing in various sports (Argus, Gill, Keogh, Hopkins, & Beaven, 2009; Argus, Gill, Keogh, McGuigan, and Hopkins, 2012; Baker, 1998; Baker & Newton, 2008; Chelly, Hermassi, Aouadi, and Shepard, 2014; Comfort, 2013; Comfort, Graham-Smith, Matthews, & Bamber, 2011; Chu, 1998; Gabbett, King, & Jenkins, 2008; Hansen et al., 2011; Holcomb, Lander, Rutland, & Wilson, 1996; Marshall, 2005; Pienaar & Coetzee, 2013). The periodized wavelike progression adapted from Baker (1998) proved to be sufficient for the maintenance of performance of the collegiate club rugby team studied. The purpose of this study was to compare the two lifting groups and how they affected a club rugby union team’s test performances. The researcher expected that there would have been improvements on all tests conducted but this was not the case. The results of the study show that the Plyometric/resistance group performed better than the Olympic/resistance group. The researcher does emphasize that the players’ scores did not significantly decline and suggests that it was a positive point that there were no significant regressions in the test scores. Given that the research took place as the team started their competitive season with no prior organized lifting program the researcher
believes that the programs in question were sufficient for maintenance of performance. It would behoove any club team to adopt such a program during their competitive season for the goals of maintenance of their performance. If a coach is not comfortable teaching one of the training methods (Olympic or Plyometric) then they could safely choose the method they know best. Overall the training showed to improve the mean speed of both groups and such a change would be an advantage later in a competitive season. It is the researcher’s belief that a coach should implement the Plyometric/resistance training program at a minimum. The secondary purpose of this study was to support club rugby by providing an in-season training program that had been studied; the programs used can be found in Appendix A.
## APPENDIX A

### Olympic and Plyometric Training Program

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Week 1</th>
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<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
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<td>Reps/%-age</td>
<td>Reps/%-age</td>
<td>Reps/%-age</td>
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<td>Iso Wall: 30 sec ea. way</td>
<td>Iso Wall: 30 sec ea. way</td>
<td>Floor: 15 sec ea. way</td>
<td>Floor: 20 sec ea. way</td>
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### Olympic and Plyometric Training Program Continued

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<td>30-36 inch</td>
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<td>BentOver Row</td>
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</tbody>
</table>
APPENDIX B

Consent Form

INFORMED CONSENT

In-Season Effect of a 6-Week Olympic Training Program Versus a Plyometric Training Program on Collegiate Club Rugby Players

You are invited to participate in a research study which will involve the investigation of the effects of a six-week Olympic weight-training program versus a Plyometric weight-training program on the in-season training benefits for non-elite rugby players. My name is Taylor Catrett, and I am a graduate student at California State University, Sacramento, Kinesiology: Strength and Conditioning. You were selected as a possible participant in this study because of your level of participation in the sport of rugby, because this information may be important to club rugby teams, and to expand the understanding training effects during competitive phases in college club teams.

The purpose of this research is to examine the effects of two different training programs during the competition phase of collegiate club rugby. If you decide to participate, you will be asked to perform testing in the Vertical Jump, the Standing Broad Jump, and 40-m sprint. The participants will then be coached through a 2-days a week, 6-week Olympic weight-training program or a Plyometric weight training program and re-tested after the last week of training. Your participation in this study will last 9-weeks with training sessions 2 days a week. For testing and familiarization of the program, you will be asked to be there for approximately 1.5 hours on testing days. Testing and familiarization days will total 9 hours. During the 6-week training program, the total time for training each day will be approximately 1 hour per session. Training days will total 12 hours. Whole program commitment will be 21 hours over a 9-week period of the study.

Every participant will be asked to perform strength training exercises such as squats, bench press, rows, core, and neck strengthening exercises. In addition, as a part of this study you may be performing Olympic weightlifting exercises that consist of the cleans and clean pulls or you may be performing Plyomtric exercises such as box jump and jump squats.

There are some possible risks involved for participants. These may include soreness of the body due to weight lifting, possible injury to muscles and joints, and bruises from the barbell. When completed correctly, these lifts are reasonably safe. The weight sessions will be coached by and overseen by a Certified Strength and Conditioning Coach to mitigate injuries.

There are some benefits to this research, particularly the development or maintenance of
strength, power, and explosiveness from adherence to the weightlifting program. Other benefits include learning proper form of lifting, techniques of Olympic lifts and Plyometric jumps, and free coaching by a certified instructor.

If you have any questions about the research at any time, please call me at 408-XXX-XXXX or Harry Theodorides, at 916-278-5051. If you have any questions about your rights as a participant in a research project please call the Office of Research Affairs, California State University, Sacramento, (916) 278-5674, or email irb@csus.edu. In the event of a research-related injury, please contact your regular medical provider and bill through your normal insurance carrier, and then advise us.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. Measures to insure your confidentiality are the protected rights of your personal information, data and names will be kept confidential, kept on a password protected computer, and hard copies of data sheets will be kept in a locked file cabinet during and after the study. The data obtained will be maintained in a safe, locked location and will be destroyed after a period of three years after the study is completed. No names will be associated with reported data.

Your participation is entirely voluntary and your decision whether or not to participate will involve no penalty or loss of benefits to which you are otherwise entitled as a Sacramento State Rugby Club participant. If you decide to participate, you are free to discontinue participation at any time with out penalty or loss of benefits to which you are otherwise entitled.

Your signature below indicates that you have read and understand the information provided above, that you willingly agree to participate, that you may withdraw your consent at any time and discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled, that you will receive a copy of this form, and that you are not waiving any legal claims, rights or remedies.

When the study is concluded you will be provided with a copy of the results and training programs.

You will be offered a copy of this signed form to keep.

Name

____________________________________

Signature                                      Date

____________________________________  ______________________________
APPENDIX C

Physical Activity Readiness Questionnaire (PAR-Q)

DATE:_________________
HEIGHT:_________ in. WEIGHT:___________ lbs. AGE:__________

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q)

Questions Yes or No

1 Has your doctor ever said that you have a heart condition and that you should only perform physical activity recommended by a doctor?

2 Do you feel pain in your chest when you perform physical activity?

3 In the past month, have you had chest pain when you were not performing any physical activity?

4 Do you lose your balance because of dizziness or do you ever lose consciousness?

5 Do you have a bone or joint problem that could be made worse by a change in your physical activity?

6 Is your doctor currently prescribing any medication for your blood pressure or for a heart condition?

7 Do you know of any other reason why you should not engage in physical activity?

If you have answered “Yes” to one or more of the above questions, consult your physician before engaging in physical activity. Tell your physician which questions you answered “Yes” to. After a medical evaluation, seek advice from your physician on what type of activity is suitable for your current condition.

Signature ___________________________ Date ___________________________
APPENDIX D

Athletic Background Questionnaire

1. Date: _________________
2. Years of weightlifting experience: _________
3. Years of rugby experience: ______________________
4. Current rugby playing position (ex. Forward or Back): ________________
5. A or B Side? ________________
6. Do you physically have issues with performing strength training exercises (i.e. squats), ballistic movements (i.e. vertical jump), Olympic lift (i.e. power clean), or jumping Plyometrics (i.e. box jumps)? If so explain why.

__________________________________________________________________
__________________________________________________________________

____________

____________
REFERENCE CITED


