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The Effect of a 13-Week, Multi-Phasic, Strength Training Program on Throwing Velocity of Elite Pitchers: an Applied Study

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The effect of a 13-week, multi-phasic, strength training program on throwing velocity of elite pitchers: An applied study

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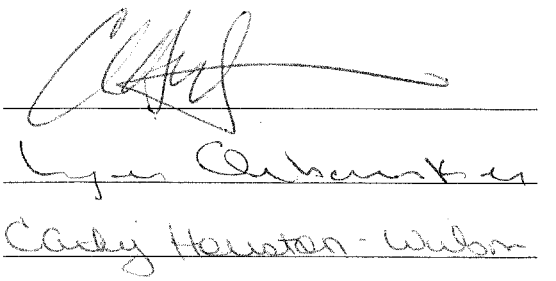

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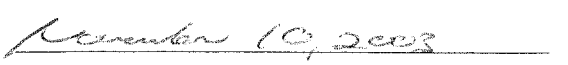

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The problem was to determine if a strength and conditioning program can increase throwing velocity of SUNY Brockport and Clarkson University varsity baseball pitchers. Participants were members of the SUNY Brockport and Clarkson University pitching staff. Thirteen participants made six throws prior to and at the conclusion of a thirteen-week strength and conditioning program. Participants engaged in the program four days per week, which included daily stretching, two strength-based phases, and a plyometric phase. There was an increase in strength in all exercises of the training program, and an increase in throwing velocity from the pre to the post-test.

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CHAPTER 1

Introduction

Sport specific training of athletes has become the standard in developing an athlete to meet the demands of a particular sport. However, there are many training programs available to coaches. Programs that adhere to muscular power, speed, and strength are common when training athletes. For example, it has been reported that college baseball players can improve throwing velocity via a structured strength-training program (Lachowetz, Evon, & Pastiglione, 1998). To explain such results, investigations have reported a positive correlation between the strength of shoulder extension muscles and throwing speed (Bartlett, Storey, & Simmons, 1989).

A significant relationship was also found between throwing speed and the strength of elbow and wrist extension movements (Pedegana, Eisner, Roberts, Lang, & Farewell, 1982). Upper extremity strength has also shown to impact throwing velocity by a comparative electromyograhic (EMG) analysis of the shoulder. Results indicated that professional pitchers were able to employ the muscles about the shoulder more effectively to achieve greater pitching velocities than amateurs (Gowan, Jobe, Tibone, Perry, & Moynes, 1987). Another relationship involving internal and external rotation and throwing velocity is seen in college baseball players. The relationship between several isokinetic measures and throwing velocity for college baseball players found significant relationships between both shoulder internal and external rotation (Pawloski & Perrin, 1989). It may be reasoned that via a strength and conditioning program and the use of proper form and technique, throwing velocity can be increased.

Throwing a baseball is comprised of several movements that require quick and powerful contractions of the skeletal muscle of both the lower and upper extremities of the body (Perilli, 1996). It is widely recognized that the ability to produce explosive force is influenced by the percentage of fast twitch muscle fibers the athlete possesses. Contractions emphasizing fast force production may stimulate fast-twitch muscle fiber development and improve the rate of force development in trained muscles (Young, 1989). Another type of training that has increased performance in baseball throwing through the use of plyometrics is ballistic resistance training (McEvoy & Newton, 1998). This training generally incorporates traditional upper body exercises (e.g., medicine ball throws), and lower body exercises (e.g., depth jumps). However, the effects of upper body plyometric training have seen minimal investigation in baseball (McEvoy & Newton, 1998). With that, many baseball coaches see traditional plyometric training as the link between strength and speed (Chu, 1983).

Emphasized in plyometrics, speed is a component found in just about every sport, and baseball is no exception. Training programs to develop speed must concentrate on the type of speed to be developed (e.g., total body, limb, acceleration, or maximal velocity). Strength training programs can result in increases in speed, both specific speed of isolated limbs and body segments, as well as general body speed (Wilmore, 1977).

In baseball, a pitcher will invariably demonstrate greater throwing velocity than all other position players. If there is one physical attribute that major league power pitchers such as Nolan Ryan, Dwight Gooden, Roger Clemens and Mark Langston have in common in their pitching delivery, it would have to be the tremendous leg drive they generate in pushing off the pitching rubber (Cimino, 1987). Outfielders and infielders

have been reported to have more upper body strength than pitchers did, whereas pitchers have more leg strength (Coleman, 1982). Elite fastball pitchers utilize the pitching mound, rubber, and an explosive leg drive as an advantage in generating maximum upper limb velocity.

To develop maximal velocity, Cimino designed a periodization program to increase both muscular strength, explosive power and endurance in especially the hips and legs as well as the upper body musculature with modifications in frequency, duration, and intensity over six phases in a one-year period among collegiate and professional baseball pitchers (see Table 1, 1987). Cimino concluded that it is possible to increase throwing velocity via a structured strength and conditioning program but indicated further research is needed.

As occurs in Cimino's program (1987), strong actions from the gluteus maximus, adductor magnus, and pectoralis major evoke strong trunk rotation and internal rotation at the shoulder are emphasized to enhance throwing velocity (Toyoshima, Hoshikawa, Miyashita, & Oguri, 1974). Furthermore, a periodization program allows training for speed, strength, and power, which is a multidimensional approach to attain greater throwing velocities (Watkinson, 1997).

Statement of the Problem

The purpose of this investigation is to determine whether a sport specific strength and conditioning program is a valid method of improving throwing velocity of SUNY Brockport and Clarkson University baseball pitchers.

Table 1 Preparation Cycle
Strength and Endurance

Body Part	Lift Type	Sets	Repetitions	Day/week	Equipment
Lower Body	Squats	3	10	3	Free Weights
	Lunges	3	10-12	3	Free Weights
	Calf Raises	3	12-15	3	Free Weights
	Dead Lift	3	10	3	Free Weights
	Abdominals	5	To failure	4	
	Power Cleans	3	6	2	Free Weights
Upper Body	Bench Press	3	15	2	Free Weights
	Military Press	3	10-12	2	Free Weights
	Pullovers	3	10	2	Barbell
	Bicep Curls	3	15	2	Dumbbells
	Triceps Extension	3	15	2	Barbell
	Wrist Curls	5	10-12	2	Barbell
	Lateral Pulls	3	10	2	Machine
	High Pulls	3	10	2	Dumbbells
	Dumbbell Raise	3	10	2	Dumbbells

Hypothesis

In a specific application of the concepts of sport specific training to the baseball throw, the hypothesis of this investigation is that a sport specific strength and conditioning program will increase throwing velocity in SUNY Brockport and Clarkson University baseball pitchers.

Operational Definitions

Throwing velocity: the velocity of the baseball thrown from a distance of sixty feet six inches from the pitching rubber to home plate as measured by a radar gun.

Sport specific strength and conditioning program: see Appendix A

Power jump: Jump as high as possible with no concern of forward speed. Each jump is maximum effort upward with the trunk erect and knees bent to slightly below a 90-degree angle. Emphasis is on height rather than speed. Begin with 10 jumps, increase by two each week.

Speed jump-tucks: Jump as high and fast as possible, bringing the knees to the chest while in the air. Jumps are performed as explosively as possible in a 15-30 second interval.

Speed jumps: Explode forward on both legs without a pause between jumps. Emphasis is on speed and distance, not height.

Box jumps: Using a square box 24 inches in height, jump onto the box as fast as possible. Control balance and jump back off the box onto the ground, immediately exploding back up. Emphasis should be on limiting time spent on the ground.

Lateral jumps: Jump over a cone or object as explosively as possible. Maintain forward position with eyes facing front. This can also be performed on one leg. Emphasis is on distance, not height.

Medicine ball side throw: Using a medicine ball, perform an explosive side throw to another player. Repeat the process allowing the ball to be caught while twisting.

Strength: The load increases as the number of repetitions decreases.

Assumptions

1. It was assumed that subjects did not do additional workouts.

2. It was assumed that subjects followed the strength and conditioning protocol using proper frequency, duration, and intensity.
3. It was assumed that the subjects used proper form and technique.
4. It was assumed that the subjects used a consistent throwing motion with each throw.

Limitations

1. The investigation is limited to strength and conditioning and the effect on throwing velocity, and is not intended to study the biomechanics of the overhand throw.

Delimitations

1. The investigation is delimited to members of the SUNY Brockport and Clarkson University varsity baseball teams.
2. The investigation is delimited to college age males.

Significance of the Investigation

In an effort to determine a program that effectively increases throwing velocity, this applied study was proposed to determine if a sport specific strength and conditioning program increases the throwing velocity of SUNY Brockport and Clarkson University varsity baseball pitchers. This study investigates the effectiveness of specific frequency and duration, repetitions and sets, and weight percentages used to produce maximum throwing velocities in college pitchers. If significant relationships can be determined, baseball coaches and strength and conditioning coaches may benefit from this investigation. More importantly, if significant relationships can be determined, elite athletes in a number of sports may benefit from this program.

CHAPTER 2

Review of Literature

In previous years, it has been thought that baseball players need to train aerobically, (i.e., running and/or biking a significant number of miles). However, swinging a bat, stealing a base, and throwing a ball requires tremendous power. For example, a pitcher may throw 100-120 pitches in the course of a nine-inning game. With each throw, maximum bursts of explosive force are exerted. For this reason, many experts agree that training anaerobically should be the focal point concerning sports that require tremendous power output. Since baseball is a sport that requires tremendous power, it is beneficial for baseball pitchers to train in that manner. Also, baseball is a sport mired by traditional attitudes toward weight training from the days when ball players came to spring training out of condition with the idea of playing their way into shape.

A study conducted by Lachowetz, Evon, & Pastiglione (1998) compared a group of twenty-two college age baseball players. Twelve players were randomly assigned to the treatment group and ten to the control group. The treatment group received eight weeks of an upper body strength-training program while the control received no training. The exercises emphasized for the treatment group were the flat bench, triceps extension, upper lat. pulldown, bicep curl, lateral row, shoulder press, internal shoulder rotation, external shoulder rotation, horizontal shoulder abduction, horizontal shoulder adduction, and shoulder extension. The results indicated that the training group had a significantly higher mean throwing velocity score than the control group at post-test. Additionally, the

training group had a significantly higher mean throwing velocity score over the pretest score.

Brown, Niehues, Harrah, Yavorsky, & Hirshman (1988) found that pitchers produced greater torque than did position players for both the dominant and non-dominant arm. Pitchers may demonstrate a greater throwing velocity due to the nature of the position, that is, repetitive practice on the mechanics and other specifics to the position that are almost exclusive to throwing a baseball. Brown, et al., (1988) suggested two possibilities to account for greater strength being displayed by the pitchers.

> This difference could be the result of the greater quantity of throwing done by pitcher's, as well as their emphasis on the quality of delivery. Genetic superiority in shoulder strength, particularly of the rotator muscles, is probably most important because strength differences were not limited just to the throwing arm. (p. 584)

Coleman's study points to the importance of leg strength over upper body strength for the higher throwing velocities. Furthermore, Coleman believes that the higher leg strength scores of pitchers may by related to the demands on the muscles of the lower extremity during the throwing motion. This study illustrated the importance of a strength and conditioning program that enhances strength gains of the lower extremities to increase throwing velocity.

Gowan, Jobe, Tibone, Perry, & Moynes (1987) study of professional versus amateur pitchers indicated that professional pitchers were able to employ the muscles about the shoulder more effectively to achieve greater pitching velocities. Furthermore,

the authors indicated that particular anaerobic training for various muscle groups can contribute to pitching performance.

> The pectoralis major, the serratus anterior, and the latissimus dorsi are other muscles used more extensively by the professional pitchers. In addition to an overall shoulder conditioning program, conditioning these muscles for strength and anaerobic endurance may enhance a player's pitching ability. (p. 590)

Strong correlations between shoulder adduction/extension and throwing speed therefore reflect the important role of the pectoralis major and latissimus dorsi muscles. The above muscle groups mentioned are an integral part to the strength and conditioning program under investigation. The internal and external rotation of the shoulder joint both horizontally and vertically were performed four days a week prior to lifting. Conditioning of the pectoralis major, the serratus anterior, and the latissimus dorsi were also targeted throughout the program. It can be reasoned that increasing the strength in the shoulder joint and the muscles surrounding it, throwing velocity can be increased as indicated by the study above. Also, exercise scientists have used multiple regression analysis to demonstrate the significant relationship between elbow extension strength, shoulder extension strength, shoulder flexion strength, and throwing speed (Pedegana, et al., 1982).

In a study evaluating the importance of lower extremity strength and active range of motion in college baseball pitchers, Tippett (1986) analyzed strength ratios between the stance leg and kick leg in active pitching. Tippet completed a thorough analysis of the lower extremity muscles involved in throwing. Several tests on the Cybex II isokinetic dynamometer were used for lower extremity strength evaluations specific to

pitching. Results indicated a significant relationship between stance and kick leg strength (especially leg external rotators) and pitching velocity, just as specific upper extremity motion and strength have been found to increase pitching velocity (Pedagana, et al., 1982).

The study conducted by McEvoy & Newton (1998) using eighteen male baseball players from two National Baseball teams using ballistic training as a component of the study resulted in an increase in throwing velocity. Thus, it appears that ballistic resistance training produces adaptations in the neuromuscular system beyond the effects of normal baseball training undertaken over the same period (McEvoy & Newton, 1998). If this is true, it indicates that ballistic resistant training is a valid method of improving throwing velocity. Furthermore, the introduction of plyometrics from the study under investigation can be advantageous and necessary in maximizing throwing speed. This training incorporates traditional upper body exercises such as medicine ball throws, and lower body exercises such as depth jumps.

Huesner & Van Huss (1978) referred to strength as an effective force provided by the musculoskeletal system. Baseball players, after proper strength training, combine that effective force with neural adaptations to improve skills such as throwing (DeRenne, Tracy, & Dunn-Rankin, 1991). Young & Bibly (1993) have determined that adaptation of the anaerobic capacity to increased high-intensity work performance has significant implications for sports that require the athlete to repeatedly generate explosive movements. Finally, Yessis (1989) suggests the only way to develop speed-strength is via fast explosive movement using light weights. The subjects in the training group were instructed to perform each muscular contraction in an explosive movement. Based on the

results of the data collected, the strength-training program appeared to be effective in increasing the rate of force development. Although no specific measurements for force development were taken, the increase in ball velocity was assumed to be a direct result of greater muscular force development. The implication of this study is that college baseball players' throwing velocity can be effectively enhanced with a proper strength and conditioning program.

Previously mentioned was the importance of fast-twitch muscle fiber development and their significance on producing explosive movement. Yet it seems that most athletes with a greater amount of fast-twitch fibers in the lower extremities also have greater amounts in the upper extremities (Gollnick & Matoba, 1984). Additionally, Janson & Kaijser (1977) have reported a close congruity between the muscle fiber composition of the upper (deltoid) and lower (vastus lateralis and gastrocnemius) extremities. Therefore, a pitcher in baseball should possess a highly anaerobic profile with a predominance of fast-twitch muscle fiber composition.

Pitching requires more than an emphasis on upper body and lower body strength. In fact, the analysis of pitchers has acknowledged the importance of total body synchronization that begins with a powerful push-off with the legs to initiate the pitching windup. Papas, Zawacki, and Sullivan (1985) establish this idea in their explanation of the pitching motion:

> Pitching is a total body activity with sequential activation of body parts through a link system which, in a right-handed pitcher, goes from the left foot to the right hand. Through the coordinated action of all body segments, ballistic energy use

with plyometrics also is applied to the baseball resulting in the greatest velocity at the time of release. (p. 216)

If the pitcher has weak leg and hip extension during push-off, the transfer of forces from the lower extremities to the upper body will decline, resulting in decreased velocity at the shoulder.

Cimino (1987) conducted a study using a one-year periodization program adhering to frequency, duration, and intensity resulting in an increase in throwing velocity. Cimino's study was designed using six phases throughout the one-year period with the goal of phase one to establish a solid strength base. Cimino had two performance goals in mind for the periodization program: (1) increase the speed of the athlete's fastball two to three miles per hour above the previous year's average without sacrificing accuracy or jeopardizing technique; and (2) maintain at least eighty percent of the muscular strength, power and endurance gains achieved during the pre-season strength and conditioning program throughout the competitive season. Moreover, Cimino's study targeted specific muscle groups similar to that of the program under investigation including the pectoral muscles, the quadriceps, and the abdominals.

It seems reasonable that a strength and conditioning program that increases strength gains of both the upper and lower body coupled with plyometric training can have a positive influence on throwing velocity as shown in the literature. The research discussed in this chapter has found positive correlations between strength training and increasing velocity. Not only is it important to increase muscle strength in the shoulder joint, it is equally important to increase muscle strength in the lower body.

Chapter 3

Methods

Subjects

The participants of the study consisted of members of the State University of New York, College at Brockport and Clarkson University varsity baseball teams. The participants of the study consisted of four seniors, four juniors, two sophomores, and three freshmen.

Instruments

Throwing velocity was measured using a handheld Pro Speed-Professional radar gun situated 2 meters directly behind home plate. The radar gun was calibrated immediately prior to all testing sessions according to the user's manual. Free weights and Nautilus equipment was used to measure strength gains for selected movements (see Table 2).

Procedures

Participants of the study were asked to sign the informed consent form consistent with the Internal Research Board (IRB) guidelines at SUNY Brockport. Participants of the study had a minimum of five years experience in the overhand throw. Each participant was asked to perform a multi-repetition maximum to measure strength gains during selected movements (see Table 2). The number of repetitions varied depending on the exercise being tested (see Table 5 & 6). The number of repetitions for each multi-repetition maximum was consistent with one another at both the pre and post-test.

Throwing velocity was assessed over the distance between the pitching rubber and home plate (sixty feet six inches). A net was placed between the tester holding the

radar gun and home plate. The gun was held at chest height and aimed at the base of the participant's body to ensure that throwing velocity was measured as the baseball passed over home plate rather than the speed of the thrower's hand (McEvoy & Newton, 1998). After an adequate warm-up consisting of muscle stretches that all subjects completed (see Table 3), participants were allowed a self-selected number of warm-up throws. Then, each participant made six throws, and the average velocity was recorded in miles per hour. Participants were asked to use a consistent, self-selected overhand throwing pattern. Throwing velocity was measured prior to the beginning of the program and at the conclusion of the thirteen weeks.

Table 2 Strength Test Exercises

Weight	*Lift Type*
Barbell	Bench Press
	Incline Press
	Dead Lift
	Squat
	Push Press
	Hang Clean
Dumbbell	Lunges
	Bicep Curl
	Forearms and Wrist
	Vertical Internal and External
	Rotation of the shoulder joint
	Horizontal Internal and
	External Rotation of the
	Shoulder joint
Nautilus Machine	Back Row Triceps Extension
	Leg Curls
	Calf Raises

Training Program

A program was specifically designed for baseball players. It was a thirteen-week program consisting of four days of strength training per week with the intent to maximize throwing velocity. The program consists of three phases throughout the thirteen weeks. Phase one was the preparation phase; phase two was the base strength phase, and phase three was the strength and power phase. Exercises targeting specific muscle groups were implemented during each of the three phases. In addition to muscle groups, the program targeted specific numbers of sets and specific numbers of repetitions.

Along with the rotator cuff muscles, exercises chosen for the core program were specific muscle groups that are believed to be most beneficial in developing throwing velocity. The core muscle groups emphasized were the pectoralis major, the hamstrings, gluteus muscles, the abdominals, and the quadriceps muscles. Specifically targeted are muscles that influence the shoulder joint (e.g., rotator cuff).

A consistent part of this program for all subjects was a stretching routine before and after every workout (see Table 3). The next component of the program was the vertical internal and horizontal internal (VIR/ HIR.) and vertical external and horizontal external rotation (VER/HER.) of the shoulder joint. These exercises were performed at the start of each workout (see Table 4).

Following the rotator cuff exercises, the major exercise components (see Table 5) and the core exercise components (see Table 6) were implemented. For the major exercise components, the number of sets and repetitions remained constant throughout the thirteen-week program. Conversely, the core exercise components number of sets and repetitions decreased throughout the program based on the phase of the program.

The frequency and intensity remained the same for both the major and core exercise components of the program.

Table 3 Stretching Exercises

Stretch Performed	Muscles Stretched	Description of Stretch	Duration
Arm Circles	Shoulder Joint	Circular motion using both arms increasing the radius with each second	30 seconds
Right Leg over Left	Hamstring, Lower Back	Right leg over the left, reach hands to the ground no bouncing	30 Seconds
Left Leg over Right	Hamstring, Lower Back	Left leg over right, reach hands to the ground no bouncing	30 seconds
Groin Stretch Right	Groin, Hip Flexor	Stretch the right with 45 degree flexion of right leg and extension of the left leg	30 seconds
Groin Stretch Left	Groin, Hip Flexor	Stretch the left with 45 degree flexion of left leg and extension of the leg	30 seconds
Hamstring Stretch	Hamstring, Lower Back	Both feet together, reach to the ground with both arms with little or no flexion in the knees, no bouncing	30 seconds
Trunk Rotation	Hip Joints, Lower Back	Hands on the hips circular motion using the trunk, reverse motion after 15 seconds	30 seconds

Table 4 Rotator Cuff Exercises

Exercise	*Frequency*	*Sets/Repetitions*	*Intensity*
VIR	4 Days	2sets/15 reps.	Failure
VER	4 Days	2sets/15 reps.	Failure
HIR	4 Days	2sets/15 reps.	Failure
HER	4 Days	2sets/15 reps.	Failure

Table 5 Major Exercises

Exercise	*Frequency*	*Sets/Repetitions*	*Intensity*
Back Row	Monday	3 sets/10 reps.	Failure
Bicep Curl	Monday	3 sets/10 reps.	Failure
Triceps Curl	Monday/Thursday	3 sets/10 reps.	Failure
Forearms/Wrists	Monday/Tuesday Thursday/Friday	3 sets/12 reps.	Failure
Situps	Monday/Tuesday Thursday/Friday	3 sets/50 reps.	50 reps.
Lateral Raise	Thursday	3 sets/10 reps.	Failure
Hammer Curl	Thursday	3 sets/10 reps.	Failure
Leg Press	Tuesday	3 sets/10 reps.	Failure
Leg Curl	Tuesday/Friday	2 sets/10 reps.	Failure
Lunges	Tuesday	2 sets/10 reps.	Failure
Calf Raises	Friday	3 sets/15 reps.	Failure

Table 6 Core Exercises

Exercise	*Phase*	*Sets/Repetitions*	*Frequency*	*Duration*	*Intensity*
Bench Press	One	4 sets/5-8 reps.	Monday	Weeks 1-5	Failure
	Two	4 sets/3-5 reps.	Thursday	Weeks 6-10	
	Three	3 sets/2-4 reps.		Weeks 11-13	
Incline Press	One	4 sets/5-8 reps.	Monday	Weeks 1-5	Failure
	Two	4 sets/3-5 reps.	Thursday	Weeks 6-10	
	Three	3 sets/2-4 reps.		Weeks 11-13	
Deadlift	One	4 sets/5-8 reps.	Monday	Weeks 1-5	Failure
	Two	4 sets/3-5 reps.	Friday	Weeks 6-10	
	Three	3 sets/2-4 reps.		Weeks 11-13	
Push Press	One	4 sets/5-8 reps.	Thursday	Weeks1-5	Failure
	Two	4 sets/3-5 reps.		Weeks 6-10	
	Three	3 sets/2-4 reps.		Weeks 11-13	
Squat	One	4 sets/5-8 reps.	Tuesday	Weeks 1-5	Failure
	Two	4 sets/3-5 reps.	Friday	Weeks 6-10	
	Three	3 sets/2-4 reps.		Weeks 11-13	
Hang Clean	One	4 sets/5-8 reps.	Tuesday	Weeks 1-5	Failure
	Two	4 sets/3-5 reps.	Friday	Weeks 6-10	
	Three	3 sets/2-4 reps.		Weeks 11-13	

The preparation phase was designed as a general conditioning phase with a duration of five weeks. The development of muscular endurance, a strength base, and technique were the specific areas of emphasis during this cycle. A rest period of one minute was utilized in phase one between sets.

The next phase was the basic strength phase with a duration of five weeks. The load was increased and the repetitions were decreased for the core exercises only. The core exercises had a 25 percent reduction of weight during the last week of the first two phases. This was incorporated to prepare the body for the next phase and possibly prevent training boredom.

The final phase of the program was the strength and power phase with a duration of three weeks. Again, the load increased as the number of repetitions decreased. A rest period of 2-3 minutes between sets was utilized in phases two and three. This was to assure for proper recovery time as repetitions decreased and weight increased.

By this time, it was expected that the athlete has developed a good strength base and proper lifting technique. During phase three, speed, strength and power are integrated in the weight training sessions for the purpose of developing "explosive power" (Cimino, 1987). To develop neuromuscular adaptations for power, the intensity (resistance) is high and the volume (repetitions 2-4) is low. The established strength base allows for the introduction of specific plyometric drills that will emphasize explosive speed and power in movements similar to those used in the pitching motion.

The final component was the implementation of plyometrics during phase three of the strength and conditioning program (see Table 7). Subjects randomly selected two

exercises for the upper body and three exercises for the lower body. Subjects were expected to perform all exercises over the three weeks.

Design and Analysis

Using a within subjects design, pre and post measurements of strength and throwing velocity were recorded. A paired t-test was used to compare pre and post-test measurements.

Table 7 Plyometric Exercises

Body Part	*Type of Exercise*	*Sets/Repetitions*	*Weight*
Upper Body	Medicine Ball Side Throw	2 sets/12 reps.	
	Medicine Ball Chest Throw	2 sets/12 reps.	
	Clap Pushup	2 sets/12 reps.	
Lower Body	Power Jumps	2 sets/12 reps.	5-10 lbs.
	Box Jumps	2 sets/12 reps.	5-10 lbs.
	Single Leg Hops	2 sets/12 reps.	
	Lateral Jumps (over cone)	2 sets/15 reps.	
	Speed Jumps	2 sets/15-30 second intervals	
	Speed Jump Tucks	2 sets/15 -30 second intervals	

Chapter 4

Results

The hypothesis of this investigation is that a sport specific strength and conditioning program will increase throwing velocity for elite baseball pitchers at SUNY Brockport and Clarkson University. Strength gains were recorded for every exercise (see Table 8).

Table 8 Percent Change of Strength Gains

Exercise	Pre-Test	Post-Test	Percent change
Lunges	38.4	50.7	13.8%
Vertical Internal Rotation	19.6	25.6	13.2%
Vertical External Rotation	19.6	25.6	13.2%
Hammer Curls	30.7	40.0	13.1%
Deadlift	155.8	202.3	12.9%
Horizontal Internal Rotation	19.6	25.3	12.6%
Horizontal External Rotation	19.6	25.3	12.6%
Forearms	36.3	46.5	12.3%
Leg Press	267.8	343.1	12.3%
Shrugs	132.3	168.1	11.9%
Squat	180.5	225.0	10.9%
Push Press	91.5	113.6	10.7%
Calf Raises	96.8	120.2	10.7%
Leg Curl	108.1	133.6	10.5%
Tricep Ext.	71.3	87.6	10.2%
Lateral Raise	29.7	36.5	10.2%
Hang Cleans	95.7	114.7	9.0%
Bicep Curl	61.5	71.5	7.5%
Bench	152.1	173.4	6.5%
Back Row	108.4	123.6	6.5%
Incline	110	125.2	6.4%

It was noted that some of the greatest significance of percent change was seen in lunges followed by the vertical and horizontal internal and external rotation of the shoulder joint. An increase in throwing velocity was observed (Table 9), and a paired t-test indicated significant increases in throwing velocity from pre to post-test (Table 10).

Table 9 Descriptive Statistics

	Mean	Std. Deviation	Std. Error of Mean
Pre	79.04	2.73	.758
Post	80.88	3.19	.886

Table 10 Paired Samples Results for Throwing Velocity (N=13)

t value	Degrees of freedom	Mean difference	Significance
-5.601	12	-1.846	.000

Chapter 5

Discussion and Conclusions

The purpose of this investigation was to determine if a sport specific strength and conditioning program will increase throwing velocity of SUNY Brockport and Clarkson University baseball pitchers. Lachowetz, Evon, & Pastiglione (1998) found that college baseball players can improve throwing velocity via a structured strength training program. Newton & McEvoy (1998) also found that ballistic resistance training can enhance performance in baseball throwing and running speed.

Strong correlations between shoulder adduction/extension and throwing speed therefore reflect the important role of the pectoralis major and latissimus dorsi muscles. The above muscle groups mentioned are an integral part to the strength and conditioning program investigated. In addition, internal and external rotation of the shoulder joint, both horizontally and vertically, were performed four days a week prior to lifting. It can be reasoned that increasing the strength in the shoulder joint and the muscles surrounding it, a positive influence in throwing velocity can be achieved (Lachowetz, et al., 1988). In addition, multiple regression analysis has demonstrated a significant relationship between elbow extension strength, shoulder extension strength, shoulder flexion strength, and throwing speed (Pedegana, et al., 1982). The results of this study indicated an increase in strength for all muscle groups over the thirteen-week program, and there were significant increases in throwing velocity from the pre to the post-test.

Cimino (1987) designed a one-year periodization conditioning program specific to fastball pitchers using frequency, duration, and intensity over six phases in a one-year period. Cimino's periodization program was designed to increase both muscular

strength, explosive power, and endurance, with an emphasis on the hips and legs, as well as the upper body musculature. The author concluded that it is possible to increase throwing velocity via a structured strength and conditioning program, but indicated further research is needed.

The difference between Cimino's study and the study being investigated was the duration and the targeting of specific muscle groups. For example, Cimino's program implemented six phases over the duration of one year; whereas, the study under investigation had a duration of thirteen weeks implementing three phases. As a sport-specific program, it was necessary to complete the training within 13 weeks. It can be suggested that a shorter program may result in similar changes in throwing velocity as cited in the literature. Furthermore, Cimino's study did not specifically target muscles involving the shoulder joint (e.g., rotator cuff). The program under investigation specifically targeted the rotator cuff by performing vertical and horizontal internal and external rotation exercises of the shoulder joint four days a week. Since the muscles of the rotator cuff have been reported to be primary contributors to throwing velocity (Lachowetz, et al., 1988, Pedegana, et al., 1982), it was expected that inclusion of these muscles and observed increases in strength would impact throwing velocity. An increase in strength in every muscle was observed over the 13-week program, as well as increases in throwing velocity from the pre to the post-test.

Future Directions

The study under investigation incorporated both strength and plyometric training during the thirteen-week program. However, a statistical increase in velocity was not observed. It was noted that at the conclusion of the program specific muscle groups

showed a greater percent change in strength than others. For example, strengthening of the shoulder joint and muscles of the lower extremities showed the greatest changes in strength throughout the program. Conversely, specific muscles of the upper extremities showed the smallest change in strength throughout the program (see Table 8). This could be deemed important for future research when implementing a strength and conditioning program to increase throwing velocity. A potential modification to the program could be emphasizing the specific muscle groups that had the greatest significance in percent change of strength gains. Furthermore, the duration of the program may need to be longer to observe changes in throwing velocity. A future study involving a longer duration and the targeting of specific muscle groups may lead to increased velocity.

Conclusions

The literature suggests that there exists a significant relationship between muscular strength and throwing velocity (Lachowetz, et al., 1988, Pedegana, et al., 1982). In support, previous authors have designed training programs and reported velocity gains (Cimino, 1987, Lachowetz, et al., 1988, Newton & McEvoy, 1998). In this study, a 13-week training program, involving all muscles reported contribute to throwing velocity, was implemented to members of the SUNY College at Brockport and Clarkson University varsity pitching staffs. Increases in strength were observed for every muscle group included in the training program, and throwing velocity increased from the pre to the post-test.

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Appendix A

State University of New York College at Brockport and Clarkson University's Baseball Strength Training Program

Introduction

This program has been specifically designed for you as a baseball player. It is a continuous program with a duration of thirteen weeks.

The Program:

This weight-training program is set up on a cycle format, using four days a week to train.

Mondays and Thursdays are explosive and upper-body days, while Tuesdays and Fridays are explosive and lower-body days, which also include plyometric workouts. We do explosive exercises every time we train.

Since baseball is an explosive game on the field, we must train the same way! Mondays and Thursdays, core exercises include bench press, incline press, and dead lifts.

Tuesdays and Fridays, core exercises consist of squats, hang cleans, and push presses.

Please see **"CYCLE"** page for core exercises. Major exercises for upper-body workouts include lateral raised, back rows, bicep curls, and forearm exercises. Major exercises to develop the lower body are front squats, leg presses, leg curls, and lunges. We train abdominals, forearms, and wrists daily!

Program Chart:

Monday	Tuesday	Wednesday
Bench - Cycle	Squat – Cycle	OFF
Incline – Cycle	Leg Press (3x10)	
Deadlift – Cycle	Hang Cleans – Cycle	
Back Row (3x10)	Lunges (2x12)	
Bicep Curls (3x10)	Leg Curls (2x10)	
Tricep Ext. (3x10)	Forearms/Wrists (3x12)	
Forearms/Wrists (3x12)		
Sit-ups (3x50)		

Thursday	Friday	Sat./Sun.
Bench - Cycle	Hang Cleans – Cycle	OFF
Push Press – Cycle	Squat – Cycle	
Incline (3x10)	Deadlifts (3x10)	
Lateral Raise (3x10)	Leg Curls (2x10)	
Hammer Curls (3x10)	Calf Raises (3x15)	
Tricep Ext. (3x10)	Sit-ups (3x50)	
Forearms/Wrists (3x12)	Forearms/Wrists (3x15)	

Pitchers – Rotator Cuff Exercises Prior to Lifting: 2 days/wk (use light wt.)

Vertical Internal Rotation (2x15)

Vertical External Rotation (2x15)

Horizontal Internal/External Rotation (2x15)

Cycle Program:

Core Exercises Only

Preparation Phase **Goal: Hypertrophy of Lean Muscle Mass**

Weeks 1-4

3-4 sets/5-8 reps

Week 5
Download
Reduce by 25%

Base Strength Phase **Goal: Establish & Develop muscular strength/condition aerobically**

Weeks 6-9
3-4 sets/3-5 reps

Week 10
Download Week
Reduce by 25%

Strength/Power Phase **Goal: Peak strength & power output/condition anaerobically**

Weeks 11-13
2-3 sets/2-4 reps

****ALL SETS DO NOT INCLUDE WARM-UP SETS**
****REMEMBER TO STRETCH BEFORE AND AFTER EVERY WORKOUT**

Plyometric Program
Twice Per Week During Phase III

A. Choose two exercises for upper body and three for lower body (vary your choices each workout).
B. Make sure to properly warm-up before starting
C. Always practice good form and technique

Upper-Body Exercises:
1. Medicine Ball Side Throws:2 sets/12 reps.
2. Medicine Ball Chest Pass: 2 sets/12 reps.
3. Clap Pushups: 2 sets/12 reps.

Lower-Body Exercises:
1. Power Jumps: 2 sets/12 reps. (using 5-10lb. Plates)
2. Box Jumps: 2 sets/12 reps. (using 5-10lb. Plates)
3. Single Leg Hops: 2 sets/12 reps.

4. Lateral Jumps (over cone): 2 sets/15 reps. (back & forth = one rep.
5. Speed Jumps: 2 sets/15-30 second intervals
6. Speed Jump-Tucks: 2 sets/15-30 second intervals

Appendix B

Statement of Informed Consent

The purpose of this study is to determine if the Brockport Baseball Strength and Conditioning program is a valid method to improve throwing velocity. This project is being conducted in order for me to complete me Master's thesis for the Department of Physical Education and Sport at the State University of New York College at Brockport.

In order to participate in this study, your informed consent is required. You are being asked to make a decision whether or not to participate in the project. If you want to participate in the project, and agree with the statements below, please sign your name in the space provided at the end. You may change your mind at any time and leave the study without penalty, even after the study has begun.

I understand that:

1. My participation is voluntary, and I have the right to refuse to participate at any time.
2. My confidentiality is guaranteed. There will be no way to connect me to any data collected concerning myself. If any publication results from this research, I would not be identified by name.
3. My participation involves multiple throwing of a baseball and strength training.
4. Approximately 24 people will take place in this study. The results will be used for the completion of a Master's thesis by the primary researcher.
5. When the thesis has accepted and approved, all consent and data forms will be destroyed.

I have read and above statements. All my questions about my participation in this study have been answered to my satisfaction. I agree to participate in the study realizing I may withdraw without penalty at any time during the process. If you have any questions you may contact:

Primary Researcher
Name: Jim Kane
Phone Number: 395-5946

Faculty Advisor
Name: Dr. Nat Goodhartz
Phone Number: 395-5342

Please print your name:_____

Signature:_____

Date:_____

Appendix C

Pre and Post Throwing Velocity Test

	1	2	3	4	5	6	Mean
Subject 1 Pre-test							
Subject 1 Post-test							
Subject 2 Pre-test							
Subject 2 Post-test							
Subject 3 Pre-test							
Subject 3 Post-test							
Subject 4 Pre-test							
Subject 4 Post-test							
Subject 5 Pre-test							
Subject 5 Post-test							
Subject 6 Pre-test							
Subject 6 Post-test							
Subject 7 Pre-test							
Subject 7 Post-test							
Subject 8 Pre-test							
Subject 8 Post-test							
Subject 9 Pre-test							
Subject 9 Post-test							
Subject 10 Pre-test							
Subject 10 Post-test							
Subject 11 Pre-test							
Subject 11 Post-test							
Subject 12 Pre-test							
Subject 12 Post-test							
Subject 13 Pre-test							
Subject 13 Post-test							