

## Comparison of Three Resistance Training Programs on Shoulder Strength and Power

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## Purpose

- To Determine the Effects of a 6 Week Baseball Training Program, involving Traditional and Non-traditional Training Groups, on Shoulder Strength and Power in High School Baseball Players Aged 14-17

## Methods

- Subjects
  - 68 high school baseball players (representing all baseball positions) were randomly and equally divided into 4 groups
    - Throwers 10 Resistance Training
    - Keiser Baseball Specific Resistance Training
    - Plyometric Resistance Training (Medball, Tubing)
    - Control Group

## Methods

- Subjects
  - There was no significant differences between subjects height, weight, and age in any group

	Age (y)	Weight (lbs)	Height (inch)
Throwers 10	15.0(1.0)	167.0(29.1)	71.4(2.7)
Keiser	15.3(1.3)	156.4(31.2)	70.8(2.0)
Plyometric	15.7(0.8)	162.0(27.5)	71.4(3.0)
Control	15.8(1.4)	166.2(28.0)	70.7(2.4)

## Methods

- Testing
  - At the Beginning and End of the 6-Week Training Session, Shoulder Strength (60 %s) and Power (300 %s and 500 %s) Was Assessed in the 3 Training Groups and the Control Group Using a Biodex Dynamometer



## Methods

- D2 Flexion Concentric/Eccentric at 60 %s & 300 %s



## Methods

- Hor Abd/Add Concentric at 60 %/s, 300 %/s, & 500 %/s



## Methods

- IR/ER Concentric/Eccentric at 60 %/s & 300 %/s
- IR/ER Concentric at 500 %/s



## Methods

- Abd/Add Concentric at 60 %/s, 300 %/s, & 500 %/s



## Methods

- Retraction/Protraction Concentric/Eccentric at 60 %/s & 300 %/s



## Methods

### •Training

- The Three Resistance Training Groups Were Trained 3 Times Per Week (M, W, F) for 6 Weeks for 45-60 min
- Both the Throwers 10 and Keiser groups used the greatest resistance possible that allowed 2 sets of 12 reps (weeks 1 and 4), 2 sets of 10 reps (weeks 2 and 5), and 2 sets of 8 reps (weeks 3 and 6)
- The Plyometric group used the greatest resistance possible that allowed 1 set of 8-12 reps for the tubing plyometrics and 2 sets of 6-10 reps for the med ball plyometrics (4-8 lb med balls were used)

## Methods

### •Training

- The Control Group did no resistance training during the 6 week period of the study
- Both the Control and Training Groups played summer baseball games 2-3 times per week during the 6 week period of the study
- The only known difference between the training and control groups during the 6 week period of the study was the training group performed resistance training and the control group did not

## Methods

### •Data Analysis

- A Two Factor Repeated Measures ANOVA was Employed ( $P < 0.05$ ) to Assess the Effect of the Training Programs on Shoulder Strength and Power
- The two factors were Group (3 training groups and 1 control group) and Test (pre-test and post-test)

## Training Group 1 (Throwers 10 – Baseball Specific and Generalized Controlled Training)



## Training Group 1 (Throwers 10)



ER & IR at 90° Abd



ER & IR at 0° Abd



D2 Diagonal Flexion



D2 Diagonal Extension

## Training Group 1 (Throwers 10)



Supination/Pronation



Bent Over Lateral Raise



1-Arm Bent Over Row



Scaption/Lateral Raise

## Training Group 1 (Throwers 10)



Wrist Flexion



Overhead Triceps Exten



Wrist Extension



Biceps Curls

## Training Group 1 (Throwers 10)



Push-ups



Press-ups

**Training Group 2  
(Keiser Baseball Specific  
Functional Explosive Training)**



**Training Group 2  
(Keiser Baseball Specific)**



Rotational Row - Start



Diagonal Lift - Start



Rotational Row - End



Diagonal Lift - End

**Training Group 2  
(Keiser Baseball Specific)**



D2 Diagonal Flexion - Start



D1 Diagonal Extension - Start



D2 Diagonal Flexion - End



D2 Diagonal Extension - End

**Training Group 2  
(Keiser Baseball Specific)**



Arm Acceleration - Start



Arm Deceleration - Start



Arm Acceleration - End



Arm Deceleration - End

**Training Group 2  
(Keiser Baseball Specific)**



Stability Chops - Start



Rotary Chops - Start



Stability Chops - End



Rotary Chops - End

**Training Group 2  
(Keiser Baseball Specific)**



Flys - Start



Reverse Flys - Start



Flys - End



Reverse Flys - End

**Training Group 2  
(Keiser Baseball Specific)**



Push-Pull - Start



Push-Pull - End

**Training Group 3  
(Plyometric – Medball & Tubing  
Generalized Explosive Training)**



**Training Group 3  
(Plyometric – Medball)**



Chest Pass - Start



Perpendicular Throw - Start



Chest Pass - End



Perpendicular Throw - End

**Training Group 3  
(Plyometric – Medball)**



Ear Throw - Start



Rotary Straight Arm - Start



Ear Throw - End



Rotary Straight Arm - End

**Training Group 3  
(Plyometric – Medball)**



Hitter's Push - Start



Squat to Thrust - Start



Hitter's Push - End



Squat to Thrust - End

**Training Group 3  
(Plyometric – Medball)**



Wood Chop - Start



Diagonal Chop - Start



Wood Chop - End



Diagonal Chop - End

### Training Group 3 (Plyometric – Medball)

Overhead Slam - Start

Overhead Slam - End

### Training Group 3 (Plyometric – Tubing)

Reverse Flys

Flexion

Flys

Extension

### Training Group 3 (Plyometric – Tubing)

External Rotation - 90° Abd

Internal Rotation - 90° Abd

External Rotation - 0° Abd

Internal Rotation - 0° Abd

### Training Group 3 (Plyometric – Tubing)

Protraction

Bench Press

Trunk Rotation

Scaption

### Training Group 3 (Plyometric – Tubing)

Arm Acceleration - Start

Arm Deceleration - Start

Arm Acceleration - End

Arm Deceleration - End

### Results

- There was a significant difference between pre-test and post-test shoulder strength and power values ( $p < 0.001$ ), and a significant interaction ( $p = 0.027$ ) between the Group and Test factors

**Results – Peak Torque (ft-lbs)  
D2 FLEXION 60°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	17% ↑
Keiser	7% ↑
Plyometric	16% ↑
Control	5% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)  
D2 FLEXION 60°/s ECCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	38% ↑ (> all 3 Groups)
Keiser	6% ↓
Plyometric	10% ↑
Control	3% ↑

**Results – Peak Torque (ft-lbs)  
D2 FLEXION 300°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	13% ↑
Keiser	12% ↑
Plyometric	5% ↑
Control	8% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)  
D2 FLEXION 300°/s ECCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	17% ↑ (> Control, Keiser)
Keiser	1% ↓
Plyometric	10% ↑
Control	5% ↓

**Results – Peak Torque (ft-lbs)  
HORIZ ABDUCTION 60°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	13% ↑ (> Control)
Keiser	3% ↑
Plyometric	2% ↑
Control	4% ↓

**Results – Peak Torque (ft-lbs)  
HORIZ ABDUCTION 60°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	17% ↑ (> Control)
Keiser	9% ↑
Plyometric	6% ↑
Control	4% ↓

**Results – Peak Torque (ft-lbs)**  
**HORIZ ADDUCTION 300°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	28% ↑ (> Control)
Keiser	11% ↑
Plyometric	28% ↑ (> Control)
Control	7% ↑

**Results – Peak Torque (ft-lbs)**  
**HORIZ ABDUCTION 300°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	70% ↑ (> all 3 Groups)
Keiser	29% ↑ (> Plyometric, Control)
Plyometric	3% ↓
Control	7% ↑

**Results – Peak Torque (ft-lbs)**  
**EXTERNAL ROTATION 60°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	3% ↑
Keiser	10% ↑
Plyometric	2% ↓
Control	2% ↓

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)**  
**EXTERNAL ROTATION 60°/s ECCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	6% ↑
Keiser	6% ↑
Plyometric	4% ↓
Control	4% ↓

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)**  
**EXTERNAL ROTATION 300°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	2% ↑
Keiser	5% ↑
Plyometric	6% ↑
Control	8% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)**  
**EXTERNAL ROTATION 300°/s ECCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	6% ↑
Keiser	1% ↓
Plyometric	7% ↓
Control	3% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)**  
**INTERNAL ROTATION 60°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	2% ↑
Keiser	1% ↓
Plyometric	12% ↓
Control	5% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)**  
**INTERNAL ROTATION 60°/s ECCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	1% ↓
Keiser	15% ↑
Plyometric	8% ↑
Control	2% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)**  
**INTERNAL ROTATION 300°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	35% ↑ (> Control)
Keiser	33% ↑ (> Control)
Plyometric	28% ↑ (> Control)
Control	4% ↑

**Results – Peak Torque (ft-lbs)**  
**INTERNAL ROTATION 300°/s ECCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	12% ↑ (> Control)
Keiser	18% ↑ (> Control)
Plyometric	12% ↑ (> Control)
Control	4% ↓

**Results – Peak Torque (ft-lbs)**  
**EXTERNAL ROTATION 500°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	2% ↓
Keiser	16% ↑ (> Throwers 10, Control)
Plyometric	26% ↑ (> Throwers 10, Control)
Control	5% ↓

**Results – Peak Torque (ft-lbs)**  
**INTERNAL ROTATION 500°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	46% ↑ (> Control)
Keiser	36% ↑ (> Control)
Plyometric	35% ↑ (> Control)
Control	7% ↑

**Results – Peak Torque (ft-lbs)  
ABDUCTION 60°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	10% ↑ (> Control)
Keiser	2% ↓
Plyometric	1% ↑
Control	6% ↓

**Results – Peak Torque (ft-lbs)  
ADDUCTION 60°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	6% ↑
Keiser	5% ↓
Plyometric	9% ↑
Control	7% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)  
ABDUCTION 300°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	15% ↑
Keiser	5% ↑
Plyometric	20% ↑
Control	7% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)  
ADDUCTION 300°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	17% ↑ (> Control)
Keiser	42% ↑ (> Throwers 10, Control)
Plyometric	74% ↑ (> all 3 Groups)
Control	1% ↑

**Results – Peak Torque (ft-lbs)  
ADDUCTION 500°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	0% ↑
Keiser	96% ↑ (> all 3 Groups)
Plyometric	38% ↑ (> Throwers 10, Control)
Control	14% ↑

**Results – Peak Torque (ft-lbs)  
RETRACTION 60°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	15% ↑
Keiser	4% ↑
Plyometric	15% ↑
Control	7% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)  
RETRACTION 60°/s ECCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	2% ↑
Keiser	5% ↑
Plyometric	9% ↑
Control	1% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)  
RETRACTION 300°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	23% ↑
Keiser	24% ↑
Plyometric	9% ↑
Control	13% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)  
RETRACTION 300°/s ECCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	4% ↑
Keiser	1% ↓
Plyometric	5% ↑
Control	7% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)  
PROTRACTION 60°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	28% ↑ (> Control)
Keiser	24% ↑ (> Control)
Plyometric	12% ↑
Control	7% ↑

**Results – Peak Torque (ft-lbs)  
PROTRACTION 60°/s ECCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	4% ↑
Keiser	7% ↑
Plyometric	1% ↓
Control	3% ↑

No Significant Difference Among Groups

**Results – Peak Torque (ft-lbs)  
PROTRACTION 300°/s CONCENTRIC**

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	22% ↑
Keiser	20% ↑
Plyometric	7% ↑
Control	17% ↑

No Significant Difference Among Groups

## Results – Peak Torque (ft-lbs) PROTRACTION 300°/s ECCENTRIC

Group	Mean % Increase/Decrease From Pre-test to Post-test
Throwers 10	6% ↑
Keiser	7% ↑
Plyometric	27% ↑ (> all 3 Groups)
Control	4% ↑

## Results

- Post Training Questionnaire
  - What Effect Did the Training Program have on Your Arm/Shoulder Strength?
    - ↓ Strength
    - No Effect
      - 1 subject → Keiser & Plyometric
    - Slightly ↑ Strength
      - 7 subjects → Thrower10 & Keiser; 11 subjects → Plyometric
    - Greatly ↑ Strength
      - 8 subjects → Thrower10; 7 subjects → Keiser; 3 subjects → Plyometric

## Results

- Post Training Questionnaire
  - What Effect Did The Training Program Have on Your Baseball Performance?
    - ↓ Performance
    - No Effect
      - 1 subject → Plyometric
    - Slightly ↑ Performance
      - 12 subjects → Thrower10, Keiser, & Plyometric
    - Greatly ↑ Performance
      - 3 subjects → Thrower10 & Keiser; 2 subjects → Plyometric

## Results

- Post Training Questionnaire
  - What is Your Overall Impression of the Training Program?
    - Did Not Enjoy
    - Neutral
    - Enjoyed to Some Degree
      - 7 subjects → Thrower10; 5 subjects → Keiser & Plyometric
    - Really Enjoyed
      - 8 subjects → Thrower10; 10 subjects → Keiser & Plyometric

## Results

- Post Training Questionnaire
  - How Hard Did You Work During The Training Program?
    - Not Hard
    - Somewhat Hard
      - 5 subjects → Thrower10; 1 subject → Keiser & Plyometric
    - Very Hard
      - 10 subjects → Thrower10; 14 subjects → Keiser & Plyometric

## Results

- Post Training Questionnaire
  - Will You Continue With a Similar Training Program Once the Program is Over?
    - No
    - Maybe
      - 5 subjects → Thrower10; 10 subjects → Keiser; 7 subjects → Plyometric
    - Yes
      - 10 subjects → Thrower10; 5 subjects → Keiser; 8 subjects → Plyometric

### Summary

- 14 of the 31 Shoulder Measurements Showed Significant Differences Among the 4 Groups
- The Results From This Study Demonstrate That Baseball Players Can Increase Shoulder Strength and Power With All 3 Training Groups, and These Exercises and Varying Training Regimens Should Be Employed in a Year Long Periodization Program

### Summary

#### AVERAGE PERCENT INCREASE

Group	CON 60°/s	ECC 60°/s	CON 300°/s, 500°/s	ECC 300°/s, 500°/s
Throwers 10	12	10	22	9
Keiser	5	5	27	4
Plyometric	5	4	23	9
Control	2	1	7	1

### Summary

- All 3 Training Groups Were More Effective Than the Control Group in Increasing Shoulder Strength and Power
- All 3 Training Groups Increased Concentric and Eccentric Shoulder Strength Approx 5-10%
- The Throwers 10 Group Was More Effective Than the Keiser and Plyometric Groups in Increasing Concentric and Eccentric Shoulder Strength
- All 3 Training Groups Increased Concentric Shoulder Power Approx 25%
- All 3 Training Groups Increased Eccentric Shoulder Power Approx 5-10%

### Summary

- All 3 Training Groups Demonstrated 30-45% Increases In Internal Rotation Peak Torque at 300 °/s and 500 °/s
- Eccentric D2 Flexion, Which Simulates Arm Deceleration, Was Significantly Greater in the Throwers 10 Group (38% ↑ at 60 °/s and 17% ↑ at 300 °/s) Compared to 3 Remaining Groups (< 10% ↑)
- Concentric Protraction at 60 °/s Was Significantly Greater in the Keiser and Throwers 10 Groups (25-30% ↑) Compared to Plyometric and Control Groups (5-10% ↑), and Eccentric Protraction at 300 °/s Was Significantly Greater in the Plyometric Group (27% ↑) Compared to Remaining 3 Groups (4-7% ↑)

### Summary

- Most Subjects in the Training Groups Said the Training Programs Did Increase Their Strength and Baseball Performance Either Slightly or Greatly
- Most Subjects in the Training Groups Said They Enjoyed the Training Program and Would Like to Continue a Similar Type of Program

*Thank You!*

