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Effects of 8-Week Plyometric Training Program on Power and Speed Test Outcomes among Novice Baseball Student Athletes

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ABSTRACT

Background: Plyometrics are considered a great way to develop “explosive power and speed” in athletes. But little data are available to support its impact on novices playing baseball. This study examines the impact of an 8-week plyometric training program on power and speed in novice baseball student athletes.

Methodology: Experimental pretest and posttest technique was used. Twenty beginner male baseball players, aged between 18–25 years, were selected by purposive sampling. The participants were divided into an experimental group (n = 20) which had pre and post intervention comparisons. 8 weeks plyometric training program applied and this was broken down into pre-program weeks (weeks 1-2) foundation exercises, explosive power (weeks 3-4), advanced power (weeks 5-6), endurance/power (weeks 7-8) and performed 3-4 times per week. The performance variables were: vertical jump (VJ), broad jump (BJ), squat jump (SJ), medicine ball rotational throw (MB Rot), and medicine ball reactive throw (MB Reac). The data was analyzed using SPSS version 26 (paired sample t-tests, correlation analysis, Cohen's d, effect size calculations).

Results: All performance variables had significant improvements. Vertical jump



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increased by 14.50 cm ($t(19) = -12.969$, $p < 0.001$, Cohen's $d = -2.900$). Broad jump improved by 16.90 cm ($t(19) = -16.476$, $p < 0.001$, Cohen's $d = -3.684$). Squat jump increased by 12.75 cm ($t(19) = -11.694$, $p < 0.001$, Cohen's $d = -2.615$). Medicine ball rotational throw improved by 0.94 m ($t(19) = -26.785$, $p < 0.001$, Cohen's $d = -5.989$), and medicine ball reactive throw improved by 4.15 m ($t(19) = -14.180$, $p < 0.001$, Cohen's $d = -3.171$). There were positive correlations between the pre-test and post-test scores with r values between 0.599 and 0.843 which were strong.

Conclusion: Novice baseball student athletes gain more power and speed from an 8week plyometric training program. The moderate to very large effect sizes provide evidence of the practical importance of the intervention. Plyometric training is a safe and valid method of enhancing athletic performance in this population.

Keywords: Plyometric Training, Explosive Power, Speed, Novice Athletes, Baseball, Neuromuscular Adaptation, Stretch-Shortening Cycle

Introduction

The modern sport science has emphasized the importance of enhancing athletic performance with evidence-based training interventions. Strength, stamina, flexibility, speed and power are a few of the physiological and physical factors which determine the performance of a sportsperson. From these, speed and power are considered as the most key factors in an explosive sport like baseball. Baseball is a game that alternates between periods of speed and bursts of activity, uses brief sprints and requires quick sprinting, batting, throwing and jumping. These movements rely on the anaerobic energy systems and neuromuscular co-ordination. With this in mind, training programs focused on increasing power and speed are crucial for enhancing performance in baseball athletes(1). Plyometric training is a type of training which involves rapid stretching (eccentric contraction) immediately followed by shortening (concentric contraction) of a muscle (the stretch-shortening cycle—SSC). The SSC is the basis for the production of explosive movements. The eccentric phase uses elastic energy to store in the muscle-tendon unit which will then be released during the concentric phase for greater force production. Box jumps, depth jumps, bounding, medicine ball throws and jump squats are a few examples of common plyometric exercises(2).

The effectiveness of plyometric training has been attributed to a number of physiological mechanisms, including neural adaptations, that increase motor unit recruitment and firing frequency, mechanical adaptations, that improve storage and release of elastic energy and muscular adaptations, that enhance activation of fast-twitch muscle fibers. Meta-analyses in the past few years have shown that lower limb strength, sprinting ability and explosive power can be significantly improved in athletes through plyometric training(3).

In baseball, integration of power and speed is required. Batting and throwing require maximum power generation in minimum time; Base running, fielding and game response require quick speed. In explosive sports, the performance of athletes is better related to their power and speed. Eight weeks is deemed to be an optimal training period to produce measurable changes in neuromuscular performance, and therefore is an appropriate time for experimental interventions(4).

Although there is a wealth of information available about plyometrics, very little has been done to study novice baseball players. This study aims to resolve this issue and assess the effects of an 8-week plyometric training program on outcomes of power and speed in novice baseball student athletes(5).



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Methodology

Study Design

The design of this study was an experimental pre-test and post-test design for measuring the effects of an 8 weeks plyometric training program on power and speed in novice baseball student athletes. Pre-test, 8-week intervention and post-test measures were completed by all participants.

Ethics

The Institutional Review Board of the Department of Emerging Allied Health Technologies, Superior University, Lahore, gave ethical clearance for this study. The goals, procedures, risks, and benefits of the study were discussed with all participants. Informed consent was done in writing prior to enrollment; consent forms were written in Urdu and English.

Setting

The study was carried out under the supervision of qualified coach/ researcher who supervised college sports ground and baseball training facility with standardized training and testing environment. The study was conducted at a well-established sports training center from 05-01-2026 to 07-03-2026.

Participants

Using purposive sampling 20 male novice baseball student athletes (18-25 years) old were selected.

Inclusion Criteria:

It involves being actively involved in baseball training and events.

No history of musculoskeletal injury in the past 6 months

Novice student athletes

Age between 18–25 years

Exclusion Criteria:

Any long-term condition or injury that affects participation should be addressed.

Experience in structured plyometric programs in last 3 months

Recent injury or illness

Running concurrently other strength/plyometric programs

Physical conditions that may affect safe participation in physical activity, such as medical issues

Variables

Independent Variable: Plyometric training

dependent Variables: Power and Speed

Outcome Measures

Primary Outcome measure: Muscular power Vertical jump test (Countermovement jump/squat jump)

Secondary Outcome Measure: Speed (Medicine Ball Throws/Jump Tests)

Data Collection Tools

Data collection was through standardized and validated tools:

Vertical jump: Using a tape measure and a jump mat. The participant will be judged on their medicine ball throws using a measuring tape (meters). All tests were carried out under controlled environment conditions which are consistent for all tests.



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Data Collection Procedure

The data collection was done in pre and post intersessions:

A pre-test was taken to establish baseline measurements of power and speed prior to training program and then after 8 weeks of training interventions in post-test.

Intervention:

There was an 8-week plyometric training program (experimental group)

Progress before and after training was measured using a post-test as all tests were repeated.

Tests were repeated in the same environment to ensure consistency of testing.

Plyometric Training Program

The 8-week plyometric training program was structured as follows:

Weeks	Exercise Type	Exercises	Sets × Reps	Sessions/Week
1-2	Foundation	Med-ball chest pass, squat jumps, ankle hops	2-3 × 8-10	3
3-4	Explosive power	Med-ball rotational throws, unilateral hops, broad jumps	3 × 8-10	3
5-6	Advanced power	Box jumps, lateral bounds, plyo push-ups, seated med-ball throws	3-4 × 6-8	3-4
7-8	Endurance + power	Single-leg bounds, reactive throws, acceleration drills, low depth jumps	3-4 × 10-12	4

Each session lasted 20–30 minutes, with 5-7 minutes warm-up, 15-20 minutes main plyometric workout, and 3-5 minutes cool-down.

Statistical Analysis

Data were analyzed using SPSS version 26. Descriptive statistics (mean and standard deviation) were computed for demographic and performance variables. Paired sample t-tests were used for within-group comparisons (pre- vs. post-intervention). Effect sizes were calculated using Cohen's d (interpreted as: small = 0.2, medium = 0.5, large = 0.8). Pearson correlation coefficients were calculated between pre- and post-test scores. Statistical significance was set at $p < 0.05$.

Ethical Consideration

The study adhered to high ethical standards including: informed consent, voluntary participation with right to withdraw without penalty, data confidentiality, no physical or psychological harm, proper safety measures during training, and institutional approval.

Results

Demographic Characteristics of Participants

A total of 20 novice male baseball student athletes completed the study. Demographic characteristics are summarized below:

Variable	Mean ± SD
Age (years)	21.70 ± 1.78
Height (cm)	174.20 ± 9.99
Weight (kg)	73.30 ± 9.03
BMI (kg/m ²)	24.33 ± 3.84



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The age distribution showed a normal bell-shaped curve ranging from 18–25 years, with most participants in the 21–23 year range. Height ranged from approximately 160–190 cm, weight from 55–90 kg, and BMI from 18–32 kg/m². All demographic variables were approximately normally distributed, confirming suitability for parametric statistical tests.

Normality Assessment

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
VJ_Pre	.135	20	.200*	.936	20	.201
VJ_Post	.200	20	.035	.900	20	.041
BJ_Pre	.122	20	.200*	.966	20	.671
BJ_Post	.112	20	.200*	.968	20	.712
SJ_Pre	.267	20	<.001	.714	20	<.001
SJ_Post	.099	20	.200*	.983	20	.964
Sprint_Pre	.147	20	.200*	.936	20	.202
Sprint_Post	.147	20	.200*	.936	20	.202
MB_Rot_Pre	.138	20	.200*	.955	20	.446
MB_Rot_Post	.120	20	.200*	.925	20	.123
MB_Reac_Pre	.182	20	.082	.939	20	.232
MB_Reac_Post	.180	20	.090	.944	20	.291
Chest_Pre	.144	20	.200*	.965	20	.642
Chest_Post	.144	20	.200*	.965	20	.642

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Most performance variables were normally distributed (Shapiro-Wilk $p > 0.05$), including VJ Pre ($p=0.201$), BJ Pre ($p=0.671$), BJ Post ($p=0.712$), SJ Post ($p=0.964$), Sprint Pre ($p=0.202$), Sprint Post ($p=0.202$), MB Rot Pre ($p=0.446$), MB Rot Post ($p=0.123$), MB Reac Pre ($p=0.232$), MB Reac Post ($p=0.291$), Chest Pre ($p=0.642$), and Chest Post ($p=0.642$). VJ Post ($p=0.041$) and SJ Pre ($p<0.001$) showed minor deviations, but parametric tests were used given the robustness of t-tests and the normal distribution of difference scores.

Paired Samples T-Test Results

The following table presents the pre- and post-intervention comparisons for all performance variables:



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Pre-Test and Post-Test Comparison of Performance Variables

Paired Samples Test

		Mean	Std. Deviation	Std. Error Mean	Paired Differences		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	VJ_Pre - VJ_Post	-14.500	5.000	1.118	-16.840	-12.160	-12.969	19	<.001
Pair 2	BJ_Pre - BJ_Post	-16.900	4.587	1.026	-19.047	-14.753	-16.476	19	<.001
Pair 3	SJ_Pre - SJ_Post	-12.750	4.876	1.090	-15.032	-10.468	-11.694	19	<.001
Pair 5	MB_Rot_Pre - MB_Rot_Post	-.9400	.1569	.0351	-1.0135	-.8665	-26.785	19	<.001
Pair 6	MB_Reac_Pre - MB_Reac_Post	-4.150	1.309	.293	-4.763	-3.537	-14.180	19	<.001

To assess the effectiveness of the intervention, the pre- and post-test scores of all the performance variables were compared by using paired samples t-tests. The results showed that the positive changes in all variables measured were statistically significant. For vertical jump (VJ), there was a significant difference between pre- and post-test scores ($M = -14.50$, $SD = 5.00$), $t(19) = -12.969$, $p < .001$, with a 95% confidence interval (CI) ranging from -16.84 to -12.16. Similarly, broad jump (BJ) showed a significant improvement ($M = -16.90$, $SD = 4.59$), $t(19) = -16.476$, $p < .001$, with a 95% CI of -19.05 to -14.75. Standing jump (SJ) also demonstrated a significant difference ($M = -12.75$, $SD = 4.88$), $t(19) = -11.694$, $p < .001$, with the 95% CI between -15.03 and -10.47. In addition, medicine ball rotational throw (MB_Rot) results indicated a highly significant improvement ($M = -0.94$, $SD = 0.16$), $t(19) = -26.785$, $p < .001$, with a 95% CI ranging from -1.01 to -0.87. Finally, medicine ball reactive strength (MB_Reac) also showed a statistically significant difference ($M = -4.15$, $SD = 1.31$), $t(19) = -14.180$, $p < .001$, with a 95% CI between -4.76 and -3.54. Overall, there is an indication that all the performance measures that were selected increased significantly due to the intervention.

Effect Size Interpretation

Effect sizes (Cohen's d) were extremely large for all variables:

MB Rotational Throw: $d = -5.989$ (extremely large)

Broad Jump: $d = -3.684$ (extremely large)

MB Reactive Throw: $d = -3.171$ (extremely large)

Vertical Jump: $d = -2.900$ (extremely large)

Squat Jump: $d = -2.615$ (extremely large)

These effect sizes indicate that the training program produced practically significant improvements beyond statistical significance.

Discussion

This study aimed to assess the effects of an 8-week plyometric training program on students' power and speed performance in novice baseball players. It was found that there was statistically significant improvement in all performance indicators, vertical jump (VJ), broad jump (BJ), squat jump (SJ), medicine ball rotational throw (MB Rot), and medicine ball reactive throw (MB Reac)(6).

The vertical jump demonstrated a mean improvement of 14.50 cm with very large effect



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size (Cohen's $d = -2.900$) and the broad jump was more impressive with a mean difference of 16.90 cm and a very large effect size (Cohen's $d = -3.684$). These findings are in line with past studies showing that plyometric exercise training improves the effectiveness of the stretch-shortening cycle and the neuromuscular control of the lower limb, thereby enhancing explosive power(7). The squat jump also demonstrated significant improvement (mean difference = 12.75 cm, Cohen's $d = -2.615$), supporting the idea of an increase in concentric explosive strength, consistent with the results of other studies that have found increases in fast-twitch muscle fiber recruitment and rate of force development with plyometric training(8).

Upper-body plyometric power measures (medicine ball throws) demonstrated significant improvements as well. The medicine ball rotational throw (Cohen's $d = -5.989$) and medicine ball reactive throw (Cohen's $d = -3.171$) had extremely large and large effect sizes, respectively(9). The results of this study are similar to those of who found that upper-extremity plyometrics increased throwing velocity and rotational power in baseball players(10).

In paired samples correlation analysis, the correlation coefficient ranged from moderate to strong positive correlation between pre-test and post-test scores for all variables ($r = 0.599$ to 0.843), indicating good reliability and consistency of responses that each individual had to the stimulus of the training. These effects sizes were large to extremely large, indicating that the improvements made were both statistically significant and meaningful(11).

This study is especially significant because it includes a group of athletes who are not commonly investigated in the research of plyometrics, that is, novice athletes. The results show that lower-body and upper-body explosive power can be significantly enhanced in a relatively short time of 8 weeks, even by novice baseball players(12). The safety and effectiveness of the adaptations was made possible by the structured, progressive approach to the program (foundation → explosive power → advanced power → endurance/power)(13).

Improvements are likely due to: Stimulation of neuromuscular efficiency, increase in stiffness of muscle-tendon, increase in elastic energy storage and release during the stretch-shortening cycle, increase in motor unit recruitment and firing frequency, and increase in fast-twitch muscle fiber activation. All these adaptations together lead to increase in the rate of force development and increase in explosive power production(14).

Conclusion

This study is a conclusion that an 8 week plyometric training program can improve power and speed in novice student athletes playing baseball(15). Each variable measured showed statistically significant improvement: vertical jump, 14.50 cm; broad jump, 16.90 cm; squat jump, 12.75 cm; medicine ball rotational throw, 0.94 m; and medicine ball reactive throw, 4.15 m. The large to extremely large effect sizes (Cohen's $d = -2.615$ to -5.989) validate the practical significance of the intervention(16).

Plyometrics are an evidence based, effective and inclusive method for enhancing athletic performance in novice populations. The program of 8 weeks was tolerated well and resulted in significant gains in both lower and upper body explosive power(17). The results of this study are congruent with the need to incorporate plyometrics into the training programs of baseball players and other explosively active sport athletes(18).



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Recommendations

Based on the results of this study, the following recommendations are made:

Plyometric exercises should be incorporated into a baseball player's training routine to improve the ability to produce power and speed.

Novice athletes should be coached through visual and demonstrated techniques.

Future studies could use more participants to improve generalizability.

Long-term effects of plyometric training should be studied in longitudinal studies.

Investigate effects in other sports and other population groups (female athletes, other disability groups)

Research should be conducted on the possible additive effects of combined plyometric and resistance training protocols.

The Study has limitations.

The following limitations should be taken into account when interpreting the results:

Small sample size (N = 20), which might limit the generalizability of the findings

Short duration of the intervention (8 weeks) that may not reflect long-term adaptations

Sample was limited to male athletes; results may not apply to females.

Extraneous variables (diet, sleep, lifestyle) were not carefully controlled

Only specific performance factors (power and speed) were measured and not other factors (agility, endurance).

Conflicts of Interest

The author(s) declare no conflicts of interest.

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