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# The Impact of Plyometric Training on Explosive Strength and Related Components in School Children

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**Abstract** This study aimed to investigate the effects of plyometric exercise on specific characteristics of school children. A total of 40 children enrolled in school were randomly assigned to either an experimental group or a control group. The experimental group participated in plyometric training sessions twice a week for a duration of 12 weeks, while the control group did not receive any form of intervention. Prior to the training, all participants underwent a pre-test to assess vertical jump, horizontal jump, leg strength, and back strength. Post-test measurements of the same variables were conducted after the plyometric training period. Paired t-tests were used to compare the differences between pre and post-test results, with a significance level set at 0.05. The findings revealed a significant improvement in explosive strength and strength-related components in the experimental group following the plyometric training intervention. In contrast, no significant improvement was observed in the control group. These results demonstrate that plyometric training has a beneficial impact on explosive strength and related components in school children. This research provides valuable insights into the potential benefits of incorporating plyometric exercises into school-based physical education programs. By integrating plyometric training, educators and coaches can promote the development of explosive strength and related physical attributes in children. Further studies are needed to explore the long-term effects and optimal training protocols of plyometric exercise in diverse populations of school children.

**Keywords:** Plyometric; Children; Performance; Training; School children
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## Introduction

Plyometric exercise is a form of training that focuses on generating maximum force in the shortest amount of time. It involves quick and powerful movements that utilize a pre-stretch or countermovement to activate the stretch-shortening cycle (Haff et al., 2016). Athletes incorporate plyometric training into their routines to enhance their skills through explosive actions. Extensive research has shown that plyometric exercise has a positive impact on the overall health and body image of teenagers. The core of plyometric training revolves around exercises such as jumping, hopping, and skipping. These exercises utilize both eccentric and concentric contractions, known as the stretch-shortening cycle (SSC) (Meylan & Malatesta, 2009). The SSC allows for the storage and release of elastic energy, resulting in increased power production. Numerous studies have thoroughly documented the benefits of plyometric training on various components of physical fitness, including power, strength, and agility. One of the main advantages of plyometric training lies in its application to sports that require explosive movements (Arazi et al., 2012). Sports like kicking, jumping, sprinting, and quick changes in direction greatly benefit from plyometric exercises. These exercises focus on explosive movements, incorporating quick stops, starts, and directional changes (Gabbett, 2000). Scientific investigations consistently demonstrate that plyometric training improves muscle strength, power, and agility (Ramírez-Campillo et al., 2014). Additionally, we believe that plyometric training can enhance acceleration, strength endurance, and speed performance in various body parts, complementing its effectiveness in developing explosive force. It is crucial to consider the appropriate application of plyometric training for different age groups. While traditionally associated with conditioning elite adult athletes, plyometric and plyometric-like exercises can also be advantageous for prepubescent and adolescent children under certain conditions. However, exercises such as depth jumps should be excluded from their routines. The age of 16 signifies a transition phase where plyometric training can be expanded beyond restricted exercises, accommodating a wider range of plyometric movements. With this in mind, the objective of our study is to investigate the effects of a 12-week plyometric training program on the power (explosive force), acceleration, strength endurance, and speed performance of 14–18-year-old students of J.N.V Ganderbal J&K. By implementing a structured plyometric training regimen, we aim to assess the impact of this training modality on the aforementioned performance factors. Our study will contribute to the existing body of knowledge regarding the benefits of plyometric training, specifically focusing on its effects in adolescent populations. Through comprehensive data collection and analysis, we anticipate gaining insights into the potential enhancements in power, acceleration, strength endurance, and speed performance. The outcomes of this study will provide valuable information to coaches, trainers, and practitioners working with young athletes, aiding in the development of evidence-based training programs that optimize performance outcomes while ensuring the safety and well-being of participants. Ultimately, our research aims to promote the appropriate and effective utilization of plyometric training in the pursuit of athletic excellence and overall physical fitness in young individuals.

## Methodology

Determining the effect of plyometric training on motor abilities was used as an experimental approach to the research. The research was conducted on a sample of 40 male students aged 16 years ± 1years, who are students of J.N.V Ganderbal school from J&K, India. The sample of 40 entities was divided into the Experimental Group and Control Group. The Experimental Group included 20 volunteers (who underwent a 12-week plyometric training program). The Control Group was divided

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into two as those who were applied pre- and post-tests to measure the initial and final performance, and those who were not applied any special training program. Subjects were assessed before and after the twelve weeks of the plyometric exercise program. All measurements were taken one week before and after training at the same time of day. Tests followed a general warm-up that consisted of running, minimize drills and stretching (see the plyometric training program).

*HORIZONTAL JUMP*

To measure lower-limb explosive strength ability, a standing broad jump was performed. Each participant was asked to stand at the starting line and jump forward as long as they could. From the starting line to the heel of the nearest foot, the gap was measured in meters. The test was repeated twice, with the higher score being held (Das & Jhajharia, 2022).

*VERTICAL JUMP*

The subjects put chalk on their fingertips to mark the wall at the height of their jump. The subject then stands away from the wall, and jumps vertically as high as possible using both arms and legs to assist in projecting the body upwards. Attempt to touch the wall at the highest point of the jump. The difference in distance between the standing reach height and the jump height is the score. The best of three attempts is recorded (Markovic, 2007).

*LEG STRENGTH (Wall squat test)*

Each subjects asked to stand comfortably with their feet approximately 2 feet from the wall and your back against a straight, smooth wall. So that their knees and hips were situated at a 90-degree angle, slide back down the wall. Adjust the feet's distance from the wall if necessary. Make sure the feet were flat on the ground, the knees were at right angles to the hips, and the back is level against the wall. Knees should be directly above your ankles, not over the toes. The thighs and ankles should be parallel to the ground. Timing starts as soon as the proper posture is adopted and ends when the subject is unable to maintain it. Calculate the score by adding up the number of seconds that each position was held (Escamilla et al., 2009).

*BACK STRENGTH (Kraus-Weber Test)*

The subjects asked to lying face down on his stomach in the "prone" posture, with their hands behind his neck and a cushion beneath lower belly. In contrast to the other Kraus Webber back strength test, when the chest is pulled down, the researcher would keep his feet planted. The researcher would instruct the individual to elevate shoulders, head and chest while counting to ten seconds. If subjects can maintain the exact posture for 10 seconds, then the subject passes this test. The test has a pass/fail grading system. If the subject maintains the stance for 10 seconds, the test is considered successful. There are 6 exercises in the Kraus-Weber test: failing to complete any one of the six exercises constitutes failure (Brown, 1967).

*PLYOMETRIC TRAINING.*

The plyometric training protocol consisted of supervised exercise sessions held twice a week on non-consecutive days (Tuesday and Thursday) for a duration of twelve weeks (Thaqi et al., 2020). The training sessions were conducted under monitored and controlled conditions. The protocol included a series of exercises starting with low-intensity jumps, followed by lateral jumps, squat jumps, left and right one-legged vertical jumps, and progressively more challenging variations of jumps. Each training session was divided into three sections: warm-up, training, and cool-down. The warm-up involved jogging at a self-selected comfortable pace, followed by a 3-minute stretching routine. During the training section, subjects performed plyometric speed and agility drills aimed at improving their ability to accelerate, decelerate, change direction, and accelerate again. The exercises were conducted in small groups, with an instructor-to-subject ratio of at least 1:3. To ensure sufficient recovery, subjects were given two minutes of rest between exercises and sets. If a participant experienced fatigue and could not perform an exercise correctly, the exercise was interrupted. Throughout the plyometric training program, participants were encouraged to perform all exercises with explosive movements. It is important to note that no injuries or damage occurred during the program. A detailed summary of the plyometric exercise program can be found in the study by Nobre et al. (2017).

*STATISTICAL ANALYSIS:*

A descriptive analysis was conducted to assess the mean and standard deviation of the tests used in this study. The normality of the data was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests (Das et al., 2023; Das & Jhajharia, 2022b). To compare the pre and post status of the health-related physical fitness components, a paired t-test was employed, with a significance level of 0.05. All calculations were performed using IBM SPSS (Version 26.00).

**Results**

**Table 1 Experimental Group Paired T-test**

| | | Paired Samples Statistics | | | Paired Differences | | |
|---|---|---|---|---|---|---|---|
| | | Mean | N | Std. Dev | Mean | Std. Dev | Sig |
| Pair 1 | Pre-Vertical Jump | 21.42 | 20 | 1.26 | -1.52 | 1.25 | 0.00 |
| | Post Vertical Jump | 22.95 | 20 | 1.97 | | | |
| Pair 2 | Pre-Horizontal Jump | 206.25 | 20 | 9.01 | -3.50 | 6.50 | 0.02 |
| | Post Horizontal Jump | 209.75 | 20 | 9.93 | | | |
| Pair 3 | Pre-Leg Strength | 63.25 | 20 | 6.34 | -7.35 | 2.75 | 0.00 |
| | Post Leg Strength | 70.60 | 20 | 6.96 | | | |
| Pair 4 | Pre-Back Strength | 8.60 | 20 | 1.27 | -0.55 | 0.82 | 0.00 |
| | Post Back Strength | 9.15 | 20 | 1.18 | | | |

Table 1 revealed the descriptive statistics and paired T-test of vertical jump, horizontal jump, leg strength and back strength before and after the plyometric training intervention. From the mean value it was observed that after plyometric training this variable were increased. The p-value indicate that there was significant improvement as the p-value is less than 0.05.

**Table 2 Control Group Paired T-test (No Training)**

| | | Paired Samples Statistics | | | Paired Differences | | |
|---|---|---|---|---|---|---|---|
| | | Mean | N | Std. Dev | Mean | Std. Dev | Sig |
| Pair 1 | Pre vertical Jump | 21.47 | 20 | 1.21 | 0.62 | 0.60 | 0.07 |
| | Post Vertical Jump | 21.67 | 20 | 1.23 | | | |
| Pair 2 | Pre-Horizontal Jump | 206.00 | 20 | 8.52 | 0.85 | 8.02 | 0.08 |
| | Post Horizontal Jump | 205.15 | 20 | 8.31 | | | |
| Pair 3 | Pre-Leg Strength | 63.50 | 20 | 5.43 | 0.10 | 2.59 | 0.86 |
| | Post Leg Strength | 63.40 | 20 | 5.40 | | | |
| Pair 4 | Pre-Back Strength | 8.45 | 20 | .99 | 0.20 | 0.89 | 0.33 |
| | Post Back Strength | 8.25 | 20 | .96 | | | |

Table 2 revealed the descriptive statistics and paired T-test of vertical jump, horizontal jump, leg strength and back strength before and after no training intervention. From the mean value it was observed that there was no increased. The p-value indicate that there was insignificant improvement as the p-value is greater than 0.05.

**Discussion**

Table 1 presents the descriptive statistics and results of paired T-tests conducted on the variables of vertical jump, horizontal jump, leg strength, and back strength, both pre- and post-plyometric training intervention. The descriptive statistics provide insights into the central tendency and variability of these variables. Upon analysing the mean values, it was observed that there was a notable increase in these variables following the plyometric training intervention. This suggests that the plyometric training program had a positive impact on the participants' vertical jump, horizontal jump, leg strength, and back strength. To determine the statistical significance of these improvements, a paired T-test was conducted. The p-value obtained from the T-test is a measure of the probability that the observed differences between the pre- and post-training values could have occurred by chance alone. In this case, the p-value was found to be less than 0.05, indicating a statistically significant improvement in the measured variables. These findings provide empirical evidence supporting the effectiveness of plyometric training in enhancing vertical jump, horizontal jump, leg strength, and back strength. The results highlight the potential benefits of incorporating plyometric exercises into training programs aimed at improving athletic performance and muscular strength in individuals. Research evidence also support this finding, according to previous research evidance plyometric improve the motor-abilities of an individual’s (Almeida et al., 2021; Thaqi et al., 2020). whereas table 2 demonstrate the descriptive statistics and paired T-test analysis



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conducted on the variables of vertical jump, horizontal jump, leg strength, and back strength before and after a period of no training intervention. The descriptive statistics provide an overview of the central tendency and variability of these variables under the absence of any training stimulus. Upon examining the mean values, it was observed that there were no substantial increases in these variables following the period of no training intervention. This suggests that the absence of training did not lead to any notable improvements in vertical jump, horizontal jump, leg strength, and back strength. To assess the statistical significance of any observed changes, a paired T-test was performed. The p-value obtained from the T-test reflects the likelihood that the observed differences between the pre- and post-training values occurred due to chance alone. In this instance, the p-value was found to be greater than 0.05, indicating an insignificant improvement in the measured variables. These findings indicate that the period of no training intervention did not result in significant enhancements in vertical jump, horizontal jump, leg strength, and back strength. It is important to note that without an appropriate training stimulus, improvements in these physical performance measures may not be expected. These results underscore the importance of structured training programs in promoting gains in vertical jump, horizontal jump, leg strength, and back strength. They emphasize the need for individuals seeking improvements in these areas to engage in purposeful training interventions rather than relying solely on natural progression or lack of training as a means of achieving significant enhancements.

## Conclusion

In conclusion, our study confirms that plyometric training effectively improves explosive strength and strength performance in both the lower and upper body. These findings support existing literature highlighting the crucial role of plyometric training in enhancing motor abilities, specifically explosive power and strength. Incorporating plyometric exercises into training programs is essential for athletes and fitness enthusiasts to optimize athletic performance and target explosive power and overall strength. These findings have practical implications for coaches and fitness professionals, emphasizing the importance of prioritizing plyometric training to maximize motor abilities. Further research is needed to explore the underlying mechanisms and long-term effects of plyometric training in different populations and sports disciplines. Overall, our study underscores the significance of plyometric training for enhancing explosive strength and strength performance.

## Conflicts of Interest

The authors declare that there is no conflict of interest in this manuscript.

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