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THE EFFECTS OF VARIED INTENSITY RESISTANCE AND PLYOMETRIC TRAINING ON EXPLOSIVE POWER IN COLLEGE VOLLEYBALL PLAYERS

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Abstract:

This study examined the impact of varying resistance and plyometric training intensities on explosive power, as measured by vertical jump height, in college-level male volleyball players. Sixty participants, aged 18 to 25, were assigned to one of four groups: high-intensity, medium-intensity, low-intensity resistance with plyometric training, and a control group with no specialized training. Each training group engaged in a twelve-week program, training three days per week. Results from Two-Way ANOVA and post hoc analyses indicated significant improvements in vertical jump height for the high-intensity group compared to all other groups. These findings suggest that high-intensity resistance with plyometric training effectively enhances explosive power in volleyball players.

Key Words: Varied Intensity Resistance Training, Plyometric Training, Explosive Power.

Introduction:

Sports participation not only enhances physical capabilities but also contributes significantly to the personal and social development of individuals. Among team sports, volleyball stands out as a dynamic and complex game that requires high levels of physical fitness, skill, and mental resilience. Volleyball involves quick movements, powerful jumps, rapid changes in direction, and precise hand-eye coordination, making it one of the most demanding sports in terms of physical conditioning. Beyond the physical, volleyball also promotes psychological attributes like focus, teamwork

Explosive power is essential for volleyball players due to the sport's demands for jumping, blocking, and spiking (Pereira et al., 2015). Vertical jump height, a measure of explosive power, is a key performance indicator in volleyball (Markovic, 2007). Training programs incorporating resistance and plyometric exercises are widely used to optimize these movements, though limited research has focused on the specific impacts of different intensity levels. This study assessed how low, medium, and high-intensity resistance with plyometric training affects explosive power among college volleyball players.

Purpose of the Study:

The primary aim of this study was to examine the effects of high, medium, and low-intensity resistance with plyometric training on vertical jump height among college-level volleyball players.

Methods:

Participants:

Sixty male volleyball players from Renugambal College of Physical Education in Tamil Nadu, India, aged 18-25, were randomly assigned to four groups: high-intensity, medium-intensity, low-intensity resistance with plyometric training, and a control group. Each group had 15 participants, who signed informed consent forms.

Training Protocol:

The training groups (high, medium, and low intensity) followed a twelve-week program, training three days per week. The high-intensity group trained at 80-90% of maximum load, medium-intensity at 60-70%, and low-intensity at 40-50%. The control group participated only in regular volleyball practice.

Measurement of Explosive Power:

Vertical jump height was used to measure explosive power, with each participant completing a standing vertical jump test before and after the training period. The best of three attempts was recorded.

Statistical Analysis:

Data were analyzed using Descriptive Statistics and Two-Way ANOVA to assess the main effects of training intensity (group) and time (pre-test and post-test) and any interaction effects. Post hoc analysis was conducted for group differences, with significance set at $p \leq 0.05$.

Results:

Explosive Power:

Descriptive Statistics and Interpretation:

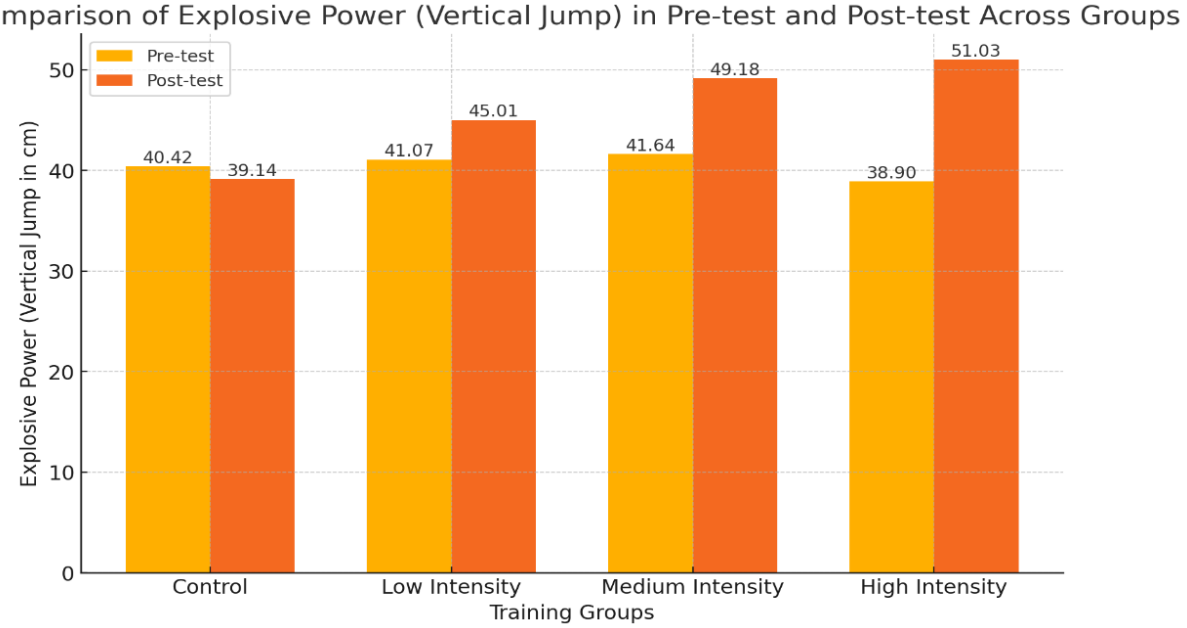
Descriptive statistics for vertical jump height across the four training groups at pre-test and post-test are presented in Table 1. At pre-test, the mean vertical jump heights were relatively similar among the groups, with the high-intensity group having a mean of 38.90 cm (SD = 2.69) and the medium-intensity group a mean of 41.64 cm (SD = 3.52). Post-test results indicated that the high-intensity group showed

the most substantial improvement in vertical jump height (M = 51.03 cm, SD = 4.02), followed by the medium-intensity group (M = 49.18 cm, SD = 4.33), and the low-intensity group (M = 45.01 cm, SD = 3.91). The control group showed minimal change from pre-test (M = 40.42 cm, SD = 5.56) to post-test (M = 39.14 cm, SD = 5.98).

Table 1: Descriptive Statistics for Vertical Jump Height Across Training Groups

Group	Test	N	Mean (cm)	SD	Min	25th %	Median	75th %	Max
Control	Pre-test	15	40.42	5.56	32.40	36.39	39.43	42.44	50.61
Control	Post-test	15	39.14	5.98	24.79	36.12	38.80	42.44	49.16
Low Intensity	Pre-test	15	41.07	5.28	32.82	37.54	40.57	44.56	50.67
Low Intensity	Post-test	15	45.01	3.91	35.24	42.29	46.40	48.04	49.50
Medium Intensity	Pre-test	15	41.64	3.52	35.86	38.95	42.74	44.10	46.53
Medium Intensity	Post-test	15	49.18	4.33	41.93	46.90	49.62	51.28	58.46
High Intensity	Pre-test	15	38.90	2.69	35.51	36.90	38.39	40.80	44.88
High Intensity	Post-test	15	51.03	4.02	44.76	48.14	51.20	53.36	59.38

Note. N = number of participants; SD = standard deviation.



Two-Way ANOVA and Interpretation:

A two-way mixed-design ANOVA was conducted to examine the effects of training intensity (control, low intensity, medium intensity, high intensity) and time (pre-test, post-test) on vertical jump height. The analysis revealed a significant main effect for group, $F(3, 112) = 9.57$, $p < .001$, indicating differences among the training groups. There was also a significant main effect for time, $F(1, 112) = 45.48$, $p < .001$, suggesting that vertical jump height changed over time across all groups. Importantly, a significant interaction effect between group and time was found, $F(3, 112) = 11.73$, $p < .001$, indicating that the changes in vertical jump height over time differed depending on the training intensity (see Table 2).

Table 2: Two-Way ANOVA for Explosive power Height

Source	SS	df	MS	F	p
Group	590.08	3	196.69	9.57	< .001
Time	934.86	1	934.86	45.48	< .001
Group × Time	723.21	3	241.07	11.73	< .001
Error (Group)	2302.32	112	20.56		

Note. SS = sum of squares; MS = mean square; df = degrees of freedom.

Post Hoc Analysis and Interpretation:

Following the significant interaction effect, post hoc comparisons using the Tukey HSD test were performed to identify specific group differences at the post-test. The high-intensity group demonstrated a significantly higher vertical jump height at post-test compared to the control group (mean difference = 11.89 cm, $p < .001$, 95% CI [6.77, 17.00]) and the low-intensity group (mean difference = 6.02 cm, $p < .001$). Similarly, the medium-intensity group showed a significantly higher post-test vertical jump than the control group (mean difference = 10.03 cm, $p < .001$, 95% CI [4.92, 15.15]) (see Table 3). No significant difference was found between the high-intensity and medium-intensity groups at post-test ($p > .05$).

Table 3: Post Hoc Comparisons for Explosive power Height at Post-Test

Comparison	Mean Difference (cm)	SE	95% CI	p
High Intensity vs. Control	11.89	1.75	[6.77, 17.00]	< .001
High Intensity vs. Low Intensity	6.02	1.75	[0.90, 11.13]	< .001
Medium Intensity vs. Control	10.03	1.75	[4.92, 15.15]	< .001
Medium Intensity vs. Low Intensity	4.17	1.75	[-1.05, 9.28]	.108
High Intensity vs. Medium Intensity	1.86	1.75	[-3.25, 6.97]	.728

Note. SE = standard error; CI = confidence interval.

Simple Effect Analysis and Interpretation:

To further explore the interaction effect, simple effect analyses were conducted to assess the effect of time within each group. The high-intensity group showed a significant increase in vertical jump height from pre-test to post-test, $F(1, 112) = 94.26$, $p < .001$, indicating a substantial improvement due to the training. The medium-intensity group also demonstrated a significant improvement, $F(1, 112) = 27.34$, $p < .001$. The low-intensity group showed a smaller yet significant increase, $F(1, 112) = 5.39$, $p = .028$. The control group did not exhibit a significant change over time, $F(1, 112) = 0.37$, $p = .550$ (see Table 4).

Table 4: Simple Effects Analysis for Explosive power Height by Group

Group	SS (Time)	df	MS	F	p
Control	12.22	1	12.22	0.37	.550
Low Intensity	116.34	1	116.34	5.39	.028
Medium Intensity	426.15	1	426.15	27.34	< .001
High Intensity	1103.37	1	1103.37	94.26	< .001

Note. SS = sum of squares; MS = mean square; df = degrees of freedom.

Interpretation:

The results indicate that high-intensity resistance and plyometric training significantly enhance explosive power, as measured by vertical jump height, among college-level male volleyball players. The high-intensity group showed the greatest improvement, followed by the medium-intensity group, while the low-intensity group showed modest gains. The lack of significant change in the control group suggests that regular volleyball practice without specialized training is insufficient for improving explosive power. These findings support the implementation of high-intensity training programs for athletes aiming to enhance their vertical jumping ability.

Discussion:

The findings of this study reveal that high-intensity resistance training combined with plyometric exercises significantly enhances explosive power, particularly in vertical jump height. This is a critical capability for volleyball players, as explosive power directly affects their ability to perform essential movements like spiking, blocking, and quick directional changes on the court. The results align with prior research, which has established that high-intensity plyometric training improves muscle strength and power by activating muscle fibers more effectively and increasing neural adaptation (Markovic, 2007; Chu & Meyer, 2013). These adaptations are particularly valuable in sports like volleyball, where explosive actions are crucial for optimal performance (Silva et al., 2019).

High-intensity plyometric exercises, such as box jumps and depth jumps, are designed to rapidly stretch and shorten muscles, activating the stretch-shortening cycle, which improves force production and reactive strength. Studies have shown that these types of exercises lead to enhanced neuromuscular efficiency and increase in muscle-tendon stiffness, both of which are beneficial for explosive athletic performance (Radcliffe &Farentinos, 2015; Verkhoshansky& Siff, 2009). For volleyball players, this means that a well-structured high-intensity plyometric training regimen can contribute to the significant improvements observed in jump height and explosive power.

The observed benefits of medium-intensity training also support findings from other research, which indicate that even moderate resistance and plyometric exercises can positively impact power and strength, though to a lesser extent than high-intensity regimens (Purkhús et al., 2016; Gjinovci et al., 2017). This level of training intensity may be appropriate for athletes who are new to plyometric exercises or have physical limitations, offering a pathway to improve performance without the risks associated with high-intensity workouts.

The importance of explosive power for volleyball is further emphasized by studies that highlight the role of vertical jump capability in player success. For example, Stojanović and Kostić (2002) demonstrated that players with higher explosive power and jump height have a clear advantage in offensive and defensive plays, as they can reach higher during spikes and block attempts. Additional research by Forthomme et al. (2005) links explosive power with an athlete's ability to respond quickly and forcefully, which is particularly useful in fast-paced sports like volleyball.

The findings of this study contribute to the broader understanding of resistance and plyometric training benefits and underscore the value of high-intensity programs for sports where explosive movements are key. Coaches and trainers may consider these findings when developing training regimens that aim to optimize player performance, particularly for movements that require maximum power output. For volleyball players, focusing on high-intensity plyometric exercises can be a strategic approach to achieving peak athletic performance.

Conclusion:

In conclusion, among college-level volleyball players, high-intensity resistance and plyometric training led to the most significant improvements in explosive power, as measured by vertical jump height. This training approach should be prioritized in conditioning programs for athletes seeking to enhance their vertical jump and overall explosive power. Future studies could extend these findings by investigating additional performance variables and by including athletes from various sports and age groups.

High-Intensity Training for Explosive Power**:** Since high-intensity resistance with plyometric training showed the greatest improvements in explosive power, volleyball coaches should prioritize high-intensity plyometric drills, such as box jumps, depth jumps, and medicine ball throws, especially for players requiring strong vertical jumps for spiking and blocking.

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