Effect of Different Training Volume and Terrains of Plyometric Training on Leg Strength and Explosive Power

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***Abstract*—The current study set out to determine how leg strength and resting pulse rate were affected by varying plyometric training volumes and terrains. Fifty male handball players from Annamalai University's various colleges participated in this study. Group I received low volume plyometric training on grass terrain (LVPTGT), Group II received low volume plyometric training on hard terrain (LVPTHT), Group III received medium volume plyometric training on grass terrain (MVPTGT), Group IV received medium volume plyometric training on hard terrain (MVPTHT), and Group V served as the control group (CG), engaging in no special training. They were split up into five equal groups, each with ten subjects. For twelve weeks, the study's training session lasted three days a week. The individuals' resting heart rate and leg strength were measured both before and after the training session. A dynamometer was used to test leg strength, and an arterial pressure pulse count was taken for one minute while the subject was at rest in order to determine the resting pulse rate. To determine if there were any significant differences between the experimental and control groups on certain criteria variables, the analysis of covariance (ANCOVA) was employed. The Scheffě S test was employed as a post-hoc test because there were five groups involved. The study's findings indicated that the experimental group had improved the criteria variables, including resting pulse rate and leg strength.**

***Index Terms*—plyometric training, different volume and terrains, leg strength and explosive power.**

I. INTRODUCTION

Sports medicine and exercise physiology view training as the process of physically exerting oneself to improve performance [1] [Singh, 1986]. Because endurance athletes do not progress rapidly, a coach cannot work miracles by taking short cuts or neglecting scientific and rigorous approaches [2] (Bompa, 1997). In populations that are prepubertal and pubertal, plyometric exercise can enhance explosive contractions by providing the required stimuli [3] (Matavulj, et al., 2001). Such a practice, which emphasises leaping, tossing, hopping, and skipping, is common in many sports and is particularly suitable in situations where developing explosive movements and vertical jumping ability is required, this applies to the handball player. With the correct technique, a progressive plan, and careful participant monitoring, young athletes' worries about their safety during plyometric exercise can be minimised [4] (Kraemer, 2002).

According to studies by Ache-Dias et al., (2016) [5] and Andrade et al., (2018) [6], plyometric training appears to improve physical attributes like strength, power, explosiveness, and even endurance performance. It also appears to improve the ability to accomplish athletic feats like sprinting speed, direction-changing ability, and jump performance (Drinkwater, Lane and Cannon, 2009; Ronnestad, et al., Markovic and Jaric, 2007 & Fouré, Nordez, and Cornu, 2012) [7-10].

The amount of research analysing the effects of plyometric training on physical skills has expanded dramatically, as have systematic reviews including meta-analysis studies. The papers covered a broad spectrum of ages, sports, and physical performance outcomes, especially over the preceding 14 years. A thorough review, considered the highest level of the evidence pyramid by Moher et al., (2009), might be conducted to provide an overview of the field's current condition and spot any methodological errors in published meta-analyses (Aromataris et al., 2015). A quick, high-intensity exercise method that can strengthen muscles is plyometric jump training (Markovic and Mikulic, 2010). Numerous research including healthy college-aged participants (Ahmadi et al., 2021; Ramirez-Campillo, et al., 2020a & Ramirez-Campillo, et al., 2020b) suggest that PJT may also improve physical fitness in a range of sports, including basketball, volleyball, and soccer.

Plyometric jump training exercises promote high rates of force creation, muscular strength and power, and force absorption muscle capacity (i.e., eccentric force). This is achieved via neuronal and tissue-related changes, such as enhanced motor unit firing strategies and/or recruitment (Ramirez-Campillo, et al., 2021b) and muscular hypertrophy (Grgic, et al., 2021). Furthermore, studies have shown that plyometric jump training improves body composition and blood pressure, among other health-related measures (Ramírez-Campillo, et al., 2016). Arazi, Mohammadi, and Asadi (2014) discovered that training in sand enhanced strength and agility in contrast to conventional plyometrics, while Impellizzeri et al., (2008) discovered that training in sand as opposed to grass enhanced sprinting, jumping, and fast running ability while reducing muscle soreness.

Some researchers have looked at the effectiveness of training on stable vs unstable surfaces. Negra et al., (2017) and Granacher et al., (2015) found comparable increases in prepubescent male football players on stable vs unstable surfaces on muscular power metrics (such as countermovement and standing jumps, sprint speeds, dynamic balance, and agility tests). Arazi, Mohammadi, and Asadi (2014) saw comparable increases in vertical jumps.

According to Almeida et al., (2021), De Villarreal et al., (2009) & Impellizzeri et al., (2008), hard surfaces are commonly utilised for plyometric training since more flexible surfaces, such as sand, tend to store muscular energy and reduce the flexible rebound power (Bishop, 2003). However, prior research has supported the use of a sand surface as a useful method for improving neuromuscular performance since it may increase the activation of the stressed muscles during the desired motor activity (Pereira, et al., 2021; Trajkovic, et al., 2016 & Miyama and Nosaka, 2004). Results from previous research have shown that the kind of training surface (such as grass, sand, or hard) impacts the degree of plyometric training impact on fitness of human being in this context (Arazi, Mohammadi and Asadi, 2014; Ozen, et al., 2020 & Hammami, et al., 2020).

II. OBJECTIVES OF THE STUDY

Since team sports entail a lot of motions that call for the effective recruitment of muscle fibres, handball is one activity where excellent explosive strength components are necessary. A single game involves slightly less than 500 high-intensity actions with about 300 changes of direction. In team sports like handball, the rate of force development is crucial. This is particularly evident in handball manoeuvres like jump shots and feints, which involve changing direction vertically. Jump shots are used to score the majority of goals and points. Plyometric training is a fantastic option for developing explosive neuromuscular performance since it uses movement structures that are comparable to those needed for a handball game. The stretch-shortening cycle (SSC), which consists of an eccentric muscular contraction followed by a concentric contraction, is the foundation of plyometric training. It seems that plyometric exercise improves neuromuscular coordination, which increases the amount of power produced. So, the objective of this study was to find out the impact of plyometric training of various volumes (low and medium) and various terrains (grass and hard surfaces) on leg strength and explosive power.

III. METHODS

A. Study participants

Handball players from male gender, that were enrolled in Annamalai University's various colleges. After examining the individuals, a doctor from Annamalai University's Cuddalore District Medical College and Hospital determined that sixty-one were qualified for the current study. The individuals were between the ages of 19 and 25, with a mean age of 22.1 ± 1.1 years. From sixty one subjects only fifty male handball players were selected as subjects and divided into five groups of ten each, group – I underwent low volume plyometric training on grass terrain (LVPTGT), group – II underwent low volume plyometric training on hard terrain (LVPTHT), group – III underwent medium volume plyometric training on grass terrain (MVPTGT), group – IV underwent medium volume plyometric training on hard terrain (MVPTHT) and group V served as the control group (CG) and was not given any additional instruction. For twelve weeks, the study's training period lasted three days a week at the time of mourning period only (6 am to 8 am).

B. Procedure

The following characteristics were chosen as criteria variables after the researchers spoke with coaches and physical education specialists: 1. Strength in the legs and 2. Power to explode. A dynamometer was used to measure leg strength, and the Sergent leap was used to measure explosive power.

C. Data Analysis

To determine if there were any significant differences between the experimental and control groups on certain criteria variables, the Analysis of Covariance (ANCOVA) was used. The significance was tested at a 0.05 level of confidence in each example, which was deemed adequate. The Scheffẽ S test was used as a post-hoc test because the current investigation contained five groups. The computer with statistical software was used to assemble and analyse the data.

D. Analysis of Data

The following table shows the analysis and presentation of the data on criteria variables between the experimental groups and the control group that was gathered before and after the experimental periods:

Table – I

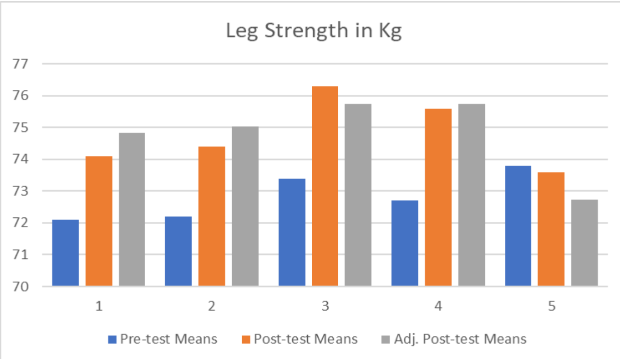
Analysis of Covariance and ‘F’ ratio for Criterion variables for experimental groups and Control Group

Variable Name	Group Name / Mean ± S.D	LVPTGT	LVPTHT	MVPTGT	MVPTHT	CG	‘F’ Ratio
Leg Strength (in Kilogram)	Pre-test Mean ± S.D	72.10 ± 5.13	72.20 ± 4.44	73.40 ± 3.06	72.70 ± 2.63	73.80 ± 3.08	0.385
	Post-test Mean ± S.D.	74.10 ± 5.17	74.40 ± 4.58	76.30 ± 2.91	75.60 ± 2.63	73.60 ± 3.31	0.841
	Adj. Post-test Mean	74.833	75.034	75.745	75.739	72.739	22.777*
Explosive power (in Centimeter)	Pre-test Mean ± S.D	0.46 ± 0.02	0.42 ± 0.025	0.446 ± 0.03	0.444 ± 0.028	0.456 ± 0.02	1.14
	Post-test Mean ± S.D.	0.483 ± 0.02	0.469 ± 0.025	0.48 ± 0.025	0.478 ± 0.026	0.453 ± 0.02	2.62*
	Adj. Post-test Mean	0.473	0.476	0.483	0.487	0.447	4.39*

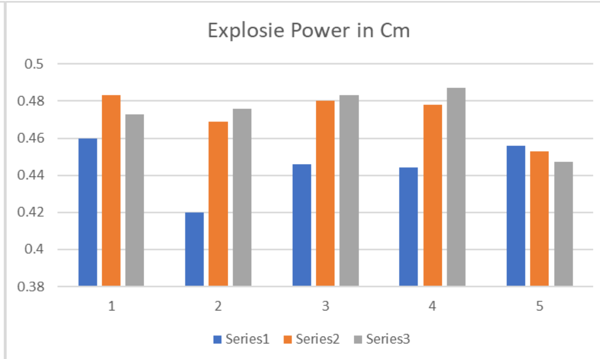
* Significant at .05 level of confidence. (The table value required for significant at 0.05 level with df 4 and 45 and 4 and 44 are 2.55 and 2.57 correspondingly).

Table – I display the ‘f’ - ratio values of pre- and post-test means of leg strength for testing groups and control group was 0.385 and 0.841, which was less significant. The ‘f’ - ratio of adjusted post-test means was 22.777, indicates that superior to the requisite table value of 2.55 for significance with df 4 and 45 at 0.05 level of self-assurance. The study's findings demonstrated a noteworthy difference in leg strength between the experimental and control groups.

The above table shows the ‘f’ - ratio values of pre- test mean of explosive power for experimental groups and control group was 1.14, which was less significant. The ‘f’ - ratio of and post- and adjusted post-test means was 2.62 and 4.39, which was superior to the requisite table value of 2.55 for significance with df 4 and 45 at .05 level of sureness.



Bar diagram showing the mean values of leg strength of experimental groups control group



Bar diagram showing the mean values of explosive power of experimental groups and control group

The Scheffě S test was used as a post-hoc test to ascertain which of the matched means had a significant difference. Table II displays the results of the follow-up test.

Table - II

Scheffě S Test for the Difference Between the Adjusted Post-Test Means of Selected Criterion variables

LVPTGT	LVPTHT	MVPTGT	MVPTHT	CG	Mean Difference	CI
Adjusted Post-test Means of Leg Strength						
74.833	75.034				0.201	1.202
74.833		75.745			0.912	1.202
74.833			75.739		0.906	1.202
74.833				72.739	2.094*	1.202
	75.034	75.745			0.711	1.202
	75.034		75.739		0.705	1.202
	75.034			72.739	2.295*	1.202
		75.745	75.739		0.006	1.202
		75.745		72.739	3.006*	1.202
			75.739	72.739	3.000*	1.202
Adjusted Post-test Means of Explosive power						
0.473	0.476				0.003	0.009
0.473		0.483			0.010*	0.009
0.473			0.487		0.014*	0.009
0.473				0.447	0.026*	0.009
	0.476	0.483			0.007	0.009
	0.476		0.487		0.011*	0.009
	0.476			0.447	0.029*	0.009
		0.483	0.487		0.004	0.009
		0.483		0.447	0.037*	0.009
			0.487	0.447	0.04*	0.009

* Significant at 0.05 level of confidence.

IV. RESULTS

After applying the Scheffẽ *S* test for the difference between the adjusted post-test means, the result shows that there was a significant difference among LVPTGT and CG, LVPTHT and CG, MVPTGT and CG and MVPTHT and CG on the changes in leg strength after the period of training for twelve weeks. In explosive power, LVPTGT and CG and LVPTHT and CG has significantly decreased. However, there was no discernible change in explosive power or leg strength across the training groups.

The differentials in adjusted post-examination mean vertical jump between the LIPTGS and MIPTGS, LIPTGS and MIPTHS, LIPTGS and CG, LIPTHS and MIPTGS, LIPTHS and CG, MIPTGS and CG, and MIPTHS and CG groups, were significantly differ. Nevertheless, at the 0.05 level of confidence, the adjusted post-examination mean difference in vertical jump between the groups receiving the LIPTGS and LIPTHS, LIPTHS and MIPTGS, MIPTGS and MIPTHS was not statistically significant at 0.05 level of confidence. The current study's subjects are essentially handball players who are more physically fit. Additionally, there was little to no gain in leg strength following their individual training regimens. However, the notable improvement was only observed in comparison to the control group.

V. DISCUSSION

The LVPTGT, LVPTHT, MVPTGT and MVPTHT have significantly increased their leg strength when compared with the CG. There was a considerable increase in leg strength following the plyometric training programme among different volume and terrains, according to Ramirez-Campillo, Andrade and Izquierdo, (2013), that the maximum strength has improved for high volume plyometric training. Rahimi and Behpur, (2005) has reported that the combination of weight and plyometric training improved the leg strength. The LVPTGT and LVPTHT, have significantly decreased their explosive power when compared with the CG. Manoranjith, Prasanna and Nagarajan, (2020) reported that the different surfaces of plyometric training have improved the explosive power. Plyometric with functional training has also significantly decrease the explosive power (Raghavendra, 2016).

VI. CONCLUSION

In conclusion, adding varying volumes of plyometric exercise to regular training on various terrains increased strength performance and somewhat reduced resting pulse, suggesting that the benefits were neurally dependent. Therefore, as a useful method of increasing both specialised and non-specific fitness, handball coaches and practitioners should add plyometric training into their handball training regimens.

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