IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Effects Of Unilateral And Bilateral Plyometric Training In Combination With Resisted Sprinting On Stride Length And Stride Frequency Of Adolescent Sprinters

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Abstract

This study aims to compare the effect of unilateral and bilateral plyometric training in combination with resisted sprint on stride length and stride frequency of adolescent boy's sprinters. Forty-five moderately trained subjects, aged 13 to 15 years studying in different schools from Idukki and Kottayam districts, of Kerala state, India were selected as subjects. The selected subjects were divided into three groups, namely Unilateral Plyometric training in Combination with Resisted Sprinting (UPTCRS) Group I (n = 15), Bilateral Plyometric Training in Combination with Resisted Sprinting (BPTCRS) Group II (n = 15) and (CG) control Group III (n=15). Both the groups performed maximal effort of plyometric leg exercises and resisted sprinting for 3 days a week for 12 weeks. Group I performed all the exercises with full repetition of each limb subsequently change to other side of the limb, the left limb followed by right limb. Group II performed all the exercises with both limbs simultaneously. The data were analyzed by using SPSS version 20, paired 't' test for each group, and ANCOVA was used to find out the effect between the groups. The paired mean differences were determined using Scheff's post hoc test whenever the adjusted post-test 'F' ratio values were found to be significant. Results of the study shows that unilateral and bilateral plyometric training in combination with resisted sprinting were significantly improved on stride length and stride frequency.

Stride length 't' ratio of UPTCRS, BPTCRS and CG were 17.63, 9.42 and 0.23 (1.09%, 0.72% and 0.01%), ($P < 0.01$), and stride frequency 't' ratio of UPTCRS, BPTCRS and CG were 3.86,6.76 and 0.25 (0.32 %, 0.28% and 0.002%), ($P < 0.01$). The conclusion of the study stated that the stride length and stride frequency of the UPTCRS training group subjects was significantly increased when compared with the CG. However, when comparing the experimental groups, UPTCRS group was better than BPTCRS group.

Key word: Unilateral plyometric training, bilateral plyometric training, resisted sprinting sprinter, stride length, stride frequency.

INTRODUCTION

Sprinting is a thrilling sport that requires a single, strong energy burst to cover a distance as fast as possible. The muscles must perform a variety of motions in quick succession, including static, eccentric, and concentric contractions, as a result of this dynamic and explosive activity. In actuality, a sprint depends on an athlete's entire coordination of arm, leg, trunk, etc. movements. To reach their maximum potential, sprinters must be able to maintain excellent body alignment in addition to having extraordinary speed. Plyometric training could be a helpful technique for improving preadolescent athletes' performance because leaping and jumping are essential abilities in a variety of sports**.** The length and frequency of the sprinter's strides determine their speed (**Johnson et al., 2011**). An athlete's stride length is often determined by the length and strength of their legs. Leg speed and frequency are often determined by the speed of muscle contractions and neuromuscular coordination. Previous researchers have established that stride length, not acceleration rate, is the primary sprinting restriction. Leg power, which has been shown to lengthen strides, is the ability to instantly apply more force, projecting the body farther and quicker with each stride. While frequency is an innate trait, increasing muscular strength and flexibility can lengthen a sprinter's stride. In contrast believes that rising naturally, a sprinter's stride length and frequency will increase their running speed. Although frequency is an intrinsic trait, it could be possible to make some progress with training. We can increase stride length and frequency by strengthening the entire body's functional strength. Improved strength conditions will reduce ground contact time and allow sprinters to produce greater power. The total force or power produced by the muscles of one or both legs working independently may be higher than the force or power produced by the muscles of both legs working simultaneously.

Athletic training programs frequently use plyometric workouts to maximize performance and lower the chance of injury. The most common plyometric workouts are bounding, hops, and jumps. One of the most common plyometric activities is jumping off a box and landing on a higher box. These exercises usually enhance power and speed. Two main methods for plyometric exercise are unilateral and bilateral training. Squat leaps and box jumps are examples of bilateral plyometric workouts, which require the simultaneous use of both limbs. The capacity of these exercises to produce high force output and enhance general muscle coordination has led to their traditional emphasis on strength and conditioning programs. Unilateral plyometric activities, like bounding or single-leg jumps, on the other hand, focus on just one limb at a time. This method is especially useful for correcting limb imbalances, improving proprioception, and boosting functional performance in sports like running and jumping which call on the production of unilateral force. By increasing the number of motor units recruited, the frequency at which nerve impulses are released, and coordination, unilateral and bilateral training can enhance the neuromuscular control of unilateral and bilateral movements, respectively, and enhance movement performance, according to the specific training principle. On unilateral limbs, unilateral training can result in neuromuscular adaptation.

Additionally, bilateral training improved bilateral motions (**Zhaoqing, 2021**). Resisted sprinting has become a popular training technique for increasing athletic explosiveness and sprint performance. Through the use of parachutes, weighted vests, resistance bands, or sleds, this training method applies external resistance while sprinting. Resisted sprint training is a type of sprint training intended to improve hip extensor neural activation and strength, which in turn increases sprinting velocity, without significantly altering running form. It involves the player sprinting with an additional load or using other types of resistance, such as hills and stairs. **(Behrencs & Simonson,2011**). This technique involves partner-resisted drills, limb 3 loading, uphill running, parachutes, elastic cord, resisted Weighted vests (WVs), and towing. **(Cronin & Hansen, 2006).** The main goal is to overload the sprinting mechanics to promote neuromuscular adaptations that result in increased power production, acceleration, and maximal sprint velocity. Many sports require sprinting, which calls for a blend of strength, speed, and coordination. By placing more strain on the lower body muscles, resisted sprinting offers a distinct stimulus in contrast to traditional sprint training, which concentrates on technique improvement and velocity enhancement. The athlete's capacity to exert force while preserving appropriate sprinting mechanics which are crucial for the best results is put to the test by this additional resistance**).** Studies have demonstrated that resisted sprinting significantly increases power generation, ground reaction forces, and stride length. The level of resistance greatly influences training results; lighter resistance (e.g., ≤20% of body weight) prioritizes adaptations related to speed, whereas heavier resistance emphasizes the development of strength. According to the specificity of the training principle, training had to be finished to discreetly replicate the requirements of certain sports.

METHODOLOGY

Subjects and Variables

The purpose of this study was to investigate the effects of unilateral and bilateral plyometric training in combination with resisted sprinting, on the stride length and stride frequency of adolescent boys' sprinters. Forty-five moderately trained subjects, age 13 to 15 years from different schools in Idukki and Kottayam districts, Kerala state, India were selected as participants and divided into three groups of fifteen each. Group I participated in UPTCRS, Group II participated in BPTCRS and Group III served as the CG. Stride length and stride frequency were assessed using a 50-meter sprint test.

Training Protocol

The training programs were scheduled for one session a day each session lasted between one hour approximately including warming up and warming down. During the training period, the experimental groups underwent their respective training program three days per week (alternative days) for 12 weeks in addition to their curriculum. Group- I Unilateral Plyometric Training in Combination with Resisted Sprinting (UPTCRS), Group II Bilateral Plyometric Training in Combination with Resisted Sprinting (BPTCRS), and Group-III on acted as a control group (CG). The unilateral plyometric training exercises included in this training program were single leg depth jump, single leg box jump, and single leg bounding. The bilateral plyometric training exercises included in this training program were double leg depth jump, double leg box jump, and double leg dounding. The resisted sprint training program was weighted vest and harness running. Group I performed all the exercises with full repetition of each limb subsequently change to other side of the limb, the left limb followed by right limb. Group II performed all the exercises with both limbs simultaneously. Group III do not participate in any special training.The training distance comprised 30-50 meters and the initial intensity was fixed at 75% and it was increased once in two weeks by 5%. Both training groups had the same volume, intensity, and frequency of training. Where the rest intervals between repetition and set are 45-60 sec and 2 minutes respectively.

Experimental Design and Statistical Technique

The study was formulated as a random group design consisting of pre and post-test conducted for all the subjects on selected criterion variables. Post-test was conducted after the experimental treatment of twelve weeks and the scores were recorded. Data were analysed by paired 't' test. Additionally, the improvement in percentage (%) was also calculated to find out the impact of the experiment. The normality of the data was found through mean, standard deviation, and 'F' ratio. The analysis of covariance (ANCOVA) was applied to find out the significant difference in each criterion variable among the groups. Whenever, the obtained 'F' ratio value for adjusted post-test means was found to be significant (0.05 level), Scheffe's post hoc test was done.

Stride length

Table-I

Descriptive Analysis on Stride Length of UPTCRS, BPTCRS and CG

Group	Test	Mean	Standard Deviation	Mean Difference	't' ratio	Percentage of Changes
UPTCRS	Pre	1.52	0.089	0.111	17.63*	1.09%
	Post	1.63	0.084			
BPTCRS	Pre	1.54	0.092	0.074	9.42*	0.72%
	Post	1.62	0.087			
CG	Pre	1.56	0.092	0.0011	0.23	0.01%
	Post	1.56	0.095			

**Significant at 0.05 level of confidence (df 2 and 14 and 2.15)*

The pre and post-test mean (M), standard deviation (SD) and mean differences (MD) values on stride length of the unilateral and bilateral plyometric training in combination with resisted sprinting and control groups are given in Table I. The calculated 't' values of UPTCRS (17.63) and BPTCRS (9.42) and CG (0.23) groups are greater to the necessary table value (df 2&14=2.15) for significance at (0.05 level). It exposed considerable Differences are present between the pre and post-test means of unilateral and bilateral plyometric training in combination with resisted sprinting groups on stride length. The result produced a 1.09% percentage of changes in stride length due to UPTCRS 0.72% of changes due to BPTCRS and 0.01% of changes in the CG. The data (pre& post) collected from the UPTCRS, BPTCRS and CG on stride length were analyzed using analysis of covariance, and the resultant outcomes are detailed in Table II.

Table – II

Analysis of Covariance Result on Stride Length of UPTCRS, BPTCRS and CG

Adjusted means of groups			SoV	Sum of Squares	df	Mean Squares (MS)	'F' ratio
UPTCRS	**BPTCRS**	**CG**					
1.65	1.62	1.54	B	0.092	2	0.046	75.19*
			W	0.025	41	0.001	

**Significant (0.05 level of confidence df 2 and 41 and 3.23)*

The adjusted means on stride length of UPTCRS (1.65), BPTCRS (1.62), and control (1.54) groups result in the 'F' ratio of 75.19 which is greater than table value (df 2&41=3.23) for significance at (0.05 level). Consequently, it is decided that major deviation be present among the adjusted means of UPTCRS, BPTCRS and CG on stride length. As the attained 'F' ratio value in the adjusted means of UPTCRS, BPTCRS and CG is found significant, the post hoc (Scheffe's) test was applied to discover the paired mean difference, as given in table number III.

Table III

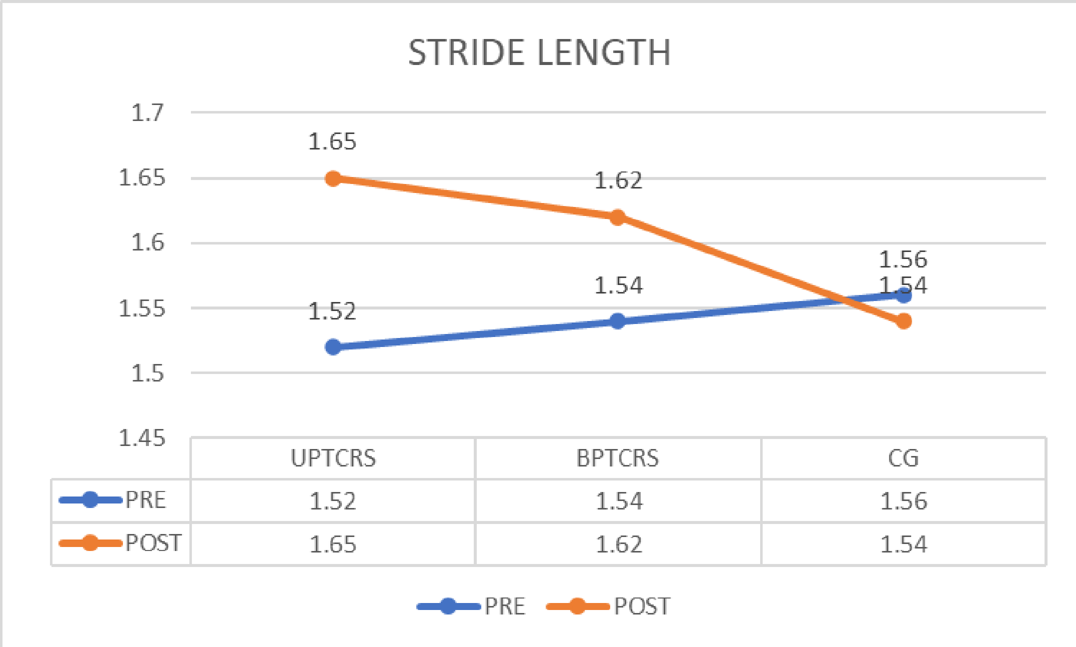
Scheffe's Test Outcomes on Stride Length of UPTCRS, BPTCRS and CG

Adjusted means of groups				
UPTCRS	**BPTCRS**	**CG**	**Mean Difference**	**Confidence Interval**
1.65	1.62		0.03*	0.02
1.65		1.54	0.11*	0.02
	1.62	1.54	0.08*	0.02

**Significant at 0.05 level of confidence*

The Scheffe's test result established that considerable mean differences are present between UPTCRS and BPTCRS (0.03), UPTCRS and CG (0.11), BPTCRS and CG (0.08) groups on stride length, because, these mean differences (MD) values are more than the confident interval (CI) value (0.02) for significance at (0.05 level). The stride length mean (pre, post & adjusted) values of experimental and control factions are in figure-1.

Figure 1



Screening Displayed the Mean Values on Stride Length (SL) of UPTCRS, BPTCRS and CG

4.7Stride Frequency

Table IV

Descriptive Analysis on Stride Frequency (SF) of UPTCRS, BPTCRS and CG

Group	Test	Mean	Standard Deviation	Mean Difference	't' ratio	Percentage of Changes
UPTCRS	Pre	3.79	0.051	0.083	3.86*	0.32%
	Post	3.88	0.072			
BPTCRS	Pre	3.79	0.067	0.071	6.76*	0.28%
	Post	3.86	0.074			
CG	Pre	3.71	0.051	0.0006	0.25	0.002%
	Post	3.71	0.051			

** Significant at 0.05 level of confidence (df 2 and 14 and 2.15)*

The 't' values of UPTCRS (3.86), BPTCRS (6.76) and CG (0.25) groups table value (df2&14=2.) for significance at (0.05 level). It exposed those considerable differences are present between the pre and post-test means of UPTCRS and BPTCRS groups on stride frequency. The result produced a 0.32% percentage of changes in stride frequency due to UPTCRS 0.28% of changes due to BPTCRS and 0.002% of changes in the CG. The data (pre & post) collected from the three groups on stride frequency was analyzed by using analysis of covariance and the resultant outcomes are detailed in table number table V.

Table V

Analysis of Covariance Result on Stride Frequency of UPTCRS, BPTCRS, and CG

Adjusted means of groups			S O V	Sum of Squares	df	Mean Squares	'F' ratio
UPTCRS	BPTCRS	CG					
3.86	3.84	3.75	B	0.067	2	0.034	12.20 *
			W	0.113	41	0.003	

**Significant at 0.05 level of significance df 2 and 41 and 3.23 respectively.)*

The means (adjusted) on stride frequency (SF) of UPTCRS (3.86), BPTCRS (3.84), and CG (3.75) groups resulted in the 'F' ratio of 12.20, which is greater than the needed table value df 2&41=3.23 for significance at (0.05 level). Therefore, it is decided that major variation are present between the adjusted means of UPTCRS, BPTCRS and CG groups on stride frequency. As the attained adjusted mean's 'F' ratio value of the groups was found significant, the post hoc (Scheffe's) test was applied to discover the paired mean differences, as given in table number VI.

Table VI

Scheffe's Test Outcomes on Stride Frequency of UPTCRS, BPTCRS and CG

Adjusted means of groups			Mean difference	Confidence Interval
UPTCRS	BPTCRS	CG		
3.86	3.84		0.02	0.05
3.86		3.75	0.11*	0.05
	3.84	3.75	0.09*	0.05

**Significant at 0.05 level of confidence.*

The mean differences between UPTCRS and CG (0.11), BPTCRS and control (0.09) groups on stride frequency (SF), are significant because these differences (MD) are more than the confident interval (CI) value (0.05) for significance (0.05 level). But there is no significant different between UPTCRS and BPTCRS (0.02). The stride length mean (pre, post & adjusted) values of experimental and control factions are in figure-2.

Figure 2

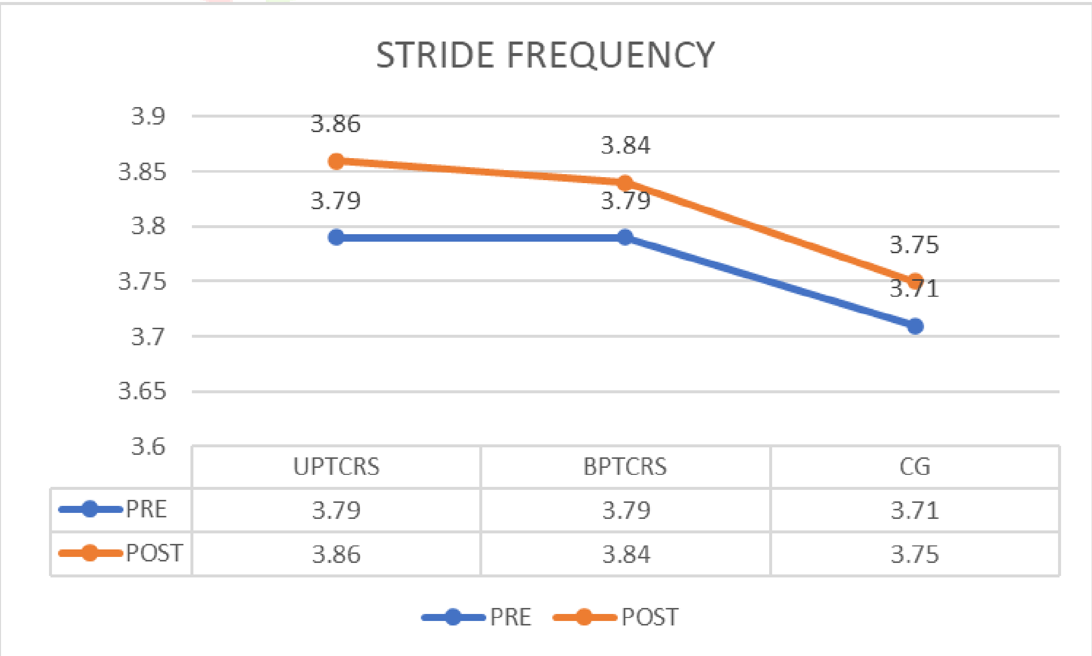


Figure Screening Displayed the Mean Values on Stride Frequency (SF) of UPTCRS, BPTCRS and CG

Discussion on Result

The result of the study was concluded that the stride length and stride frequency of the unilateral and bilateral plyometric training in combination with resisted sprint training group subjects was significantly changed when compared with the control group. However, when comparing the experimental groups there were significant differences existed among them in improving the stride length and stride frequency. Among the experimental group, unilateral plyometric training combination with resisted sprint training had a high impact to increase the stride length and stride frequency of the subjects. The following studies support the current study results. Stride length may grow due to the muscle's increased ability to withstand larger stretch loads, store more elastic energy, and produce more power. Uphill and downhill sprint training was found to increase stride frequency (**Slawinski et.al 2008).** According to **Spinks et al. (2007),** stride length may be increased by making better use of elastic energy during the sprint cycle's support phase. To produce force and transfer energy, the foot must be in touch with the ground during the support phase. An athlete may produce more propulsion with each stride and achieve longer strides when they efficiently store and release elastic energy, mostly through the stretch-shortening cycle (SSC) in muscles and tendons. There is evidence that unilateral plyometric training may be more effective, compared with bilateral plyometric training in adults **(Bogdanis, Donti, et al., 2019).** Plyometric and resisted sprint training regimens have developed into extremely regimented training regimens for improving athlete performance. It is a successful training technique intended to produce improvements in speed-related parameters. stride frequency was improved by uphill and downhill sprint training.(**Michale CR 2008).**

Conclusions

The conclusion of the study stated that the stride length and stride frequency of the unilateral and bilateral plyometric training in combination with resisted sprint training group subjects was significantly increased when compared with the control group. However, when comparing the experimental groups, the unilateral plyometric training in combination with the resisted sprinting group was better than the bilateral plyometric training in combination with resisted sprinting group. This study observed that, unilateral and bilateral plyometric training in combination with resisted sprint training are significantly improved stride length and stride frequency of adolescent boys' sprinters. In this light, the training modalities are strongly suggestable for the improvement of sprint kinematics of athletes. Stride length may grow due to the muscle's increased ability to withstand larger stretch loads, store more elastic energy, and produce more power. Uphill and downhill sprint training was found to increase stride frequency. Plyometric and resisted sprint training regimens have developed into extremely regimented training regimens for improving athlete performance. It is a successful training technique intended to produce improvements in speed-related parameters.

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