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COMPARISON OF RESISTANCE TRAINING AND PLYOMETRIC TRAINING FOR THE DEVELOPMENT OF SPEED OF THE ATHLETES

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ABSTRACT

The purpose of the present study was to compare the effectiveness of Plyometric Training (PT) and Resistance Training (RT) for improving speed ability of the Athletes. Total thirty six (N = 36) district level athletes were randomly selected. All the subjects were divided into three equal groups: i) Resistance Training Group (RTG) as Experimental Group-I, ii) Plyometric Training Group (PTG) as Experimental Group-II and iii) Control Group (CG). Experimental group-I underwent resistance training whereas experimental group-II underwent plyometric training for eight weeks. But the control group did not involve in any of the above treatments. In the present study speed ability was measured through 60 yard dash. To draw the statistical inference analysis of covariance (ANCOVA) was used followed by Tukey's LSD test as post hoc test. Both RTG and PTG improved significantly with respect to the CG in speed ability. Significant difference was also observed between RTG and PTG in speed ability. It was also confirmed that the PTG improved better than the RTG in speed ability. From the above findings it can be concluded that PT is more effective training means than RT to improve the speed ability of the athlete.

Keywords: *Plyometric Training, Resistance Training, Speed Ability, Stretch Shortening Cycle.*

Introduction

Sports training is a targeted process of preparation of sports persons based on scientific principles aimed at improving and maintaining highest performance capacity in different sports activities (Singh, 1991). It includes different physical, physiological and psychological traits and components. The important physical factors that the sports coaches take into their considerations are strength, speed, agility, power, coordination, endurance, flexibility etc. The optimum development of these factors needed specific training programs. There are various methods of sports training in this

regard like plyometric training, resistance training, cross training, interval training etc. Sports coaches and trainer are fond of introducing new training means and modalities over the course of their training targeted for the development of the performance factors. The sports trainers often become confused while selecting an appropriate training means for the development of a particular performance factor. The trainer and coaches wanted to be confirm in this regard whether the training means selected by him for developing a trait is the best means or not? There are also several other constraints and challenges like time, availability of equipments and other training facilities that also faced by a trainer or coach while selecting the training method (Whitehead *et al.*, 2018). Considering these factors, one should be careful and critically analyzed the training program that need to be selected.

In most of the sports, the top performances are largely influenced by speed ability. That is why sports coaches and trainers gives prime importance on the training means that improved speed ability. Plyometric and Resistance training are two of the most powerful training methods used in training programs to improve speed ability of an athlete. Various research study reported that plyometric and resistance training, being an effective training method, have been included as part of an overall seasonal training program (Whitehead *et al.*, 2018).

Plyometric exercises characterized by explosive power output, explosive reactivity and eccentric muscle contraction during dynamic movements (Coetzee, 2007). The potential benefit of plyometric training basically depends on its contraction mechanism that involves the *Stretch Shortening Cycle* (SSC). SSC consisted of three phases, phase-I i.e. eccentric phase that involves the preloading phase, phase II, which is the time between the eccentric and concentric muscle actions, it's also called amortization, and phase III is the concentric phase or de-loading phase (Cavagna, 1970; Chu, 1998; Haff & Triplett, 2015; Ramirez-Campillo *et al.*, 2018). More contractile force is produced by a muscle while it stretched in an optimum range prior to the desired movement (Bosco & Viitasalo, 1982; Bosco *et al.*, 1981; Whitehead *et al.*, 2018). Plyometric exercises consisted of spot jumps, standing jumps, multiple hops and jumps, bounding, box drills, and depth jumps etc.

On the other hand, Resistance training, especially, plays a key role in improving muscle strength, power and muscle hypertrophy. Speed ability can also be improved through resistance training. Seed performance consisted of various phases like initial acceleration, maximum speed and transition phase (Delecluse, 1997). In resistance training different exercises improves the muscles strength and power which are associated with sprint performance. Isotonic resistance training generally uses eccentric and concentric muscle contraction periodically that improves the load bearing ability of the joints in response to a training stimulus. In any training means whether it is plyometric or resistance training, to obtain the desired training effect, load are controlled by

manipulating the intensity, frequency and volume where principles of progression of load is followed Plyometric training may be effective for developing the rate of force production during jumping and sprinting, on the other hand resistance training is required to develop muscular strength and acceleration (Delecluse, 1997; Fleck & Kraemer, 2014; Whitehead *et al.*, 2018).

Thus, both the training programs are crucial for the development of different physical abilities of the athletes though the mechanisms are different. But it is also important to justify which training means is more effective for the development of speed ability of the athletes. Coaches and trainers are often confused while selecting the appropriate training means for the development of speed abilities. To get the satisfied answer they depends on the research work conducted on these two training means from a comparative stand point. As per the literature is concern, the studies conducted in this regard were not enough and required further investigation in this area of knowledge. The present research work was such an attempt to find out the best training means between plyometric training & resistance training for the improvement of speed. Therefore the purpose of the present research was to compare the effectiveness of Plyometric Training (PT) with respect to Resistance Training (RT) for improving speed ability of the Athletes.

Materials and Methodology

Under this section *experimental approach* to the problem, *Participants*, *Experimental Protocol*, *variable Studied and statistical Analysis* have been presented.

Experimental Approach to the Problem

This study was conducted to compare the effectiveness of two different types of sports training i.e. Resistance Training and Plyometric Training on speed ability of the athletes. In the present study speed was measured through 60 yard dash test (Rani, 2018; Bhowmi *et al.*, 2016; Hebbelinck & Postma, 1963; Crotin, 2009). For the purpose of the study thirty six district level athletes age range between 14 to 18 years were randomly selected and were divided into three equal groups: i) *Resistance Training Group (RTG) as Experimental Group-I*, ii) *Plyometric Training Group (PTG) as Experimental Group-II* and iii) *Control Group (CG)*. Equated group design was adopted in the present study. All the experimental groups were involved in the respective training schedules.

Participants

Thirty six (N = 36) district level athletes were randomly selected as subjects for the present study having at least three years up to maximum five years of training age, from Nadia district of West Bengal. The age ranged of the subjects was from 14-18 years. All the subjects were belonging from the same athletic training academy. But as it was not a residential academy, their socioeconomic status, food habit, lifestyle and daily routine etc. were not under the control of the researchers during the experimentation.

Experimental Protocol

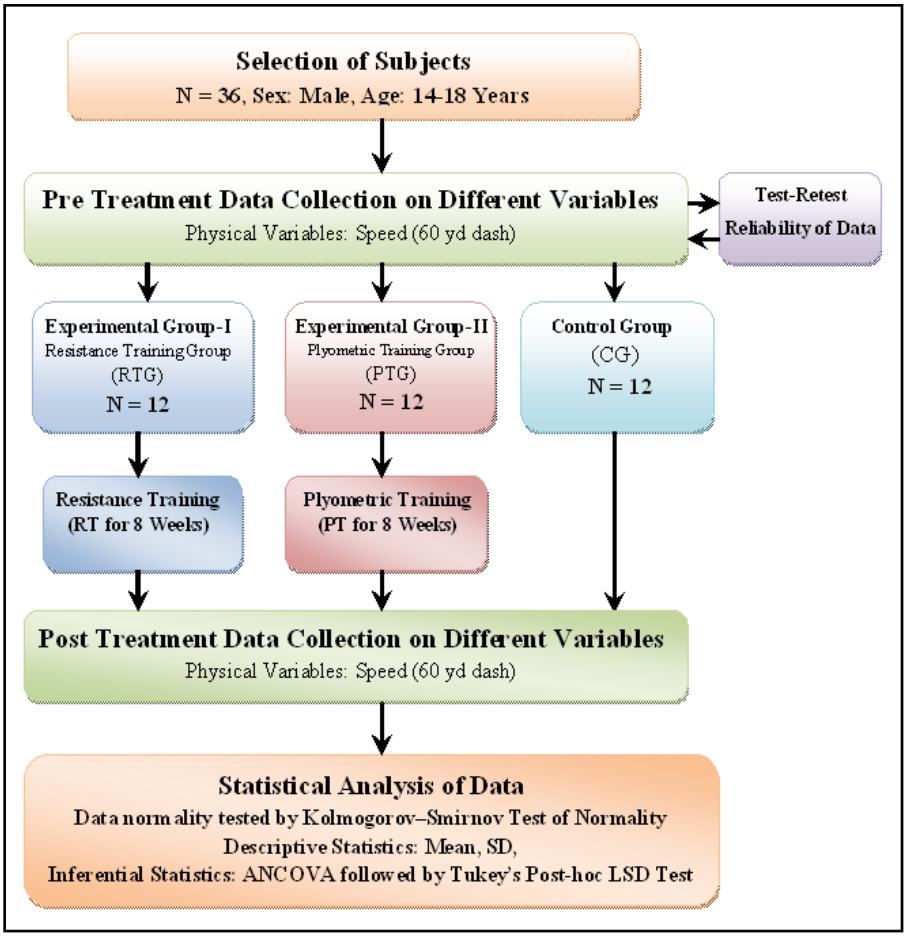

Figure 1: Flow Chart of Experimental Design

Both the Training programs were intervened for eight weeks on the respective experimental groups. Experimental Group-I (RTG) underwent Resistance Training (RT), whereas Experimental Group-II (PTG) underwent Plyometric Training (PT) (**Fig. 1**). But the control group did not involve in any of the above plyometric treatments. But all the three groups were involved in their daily routine activities which were beyond the control of the researchers. Prior to start the training program both groups were given proper warm-up and after the completion of the training they were given cooling down exercises also. The training program were intervened for three days in a week and 90-120 min total session daily including the time of warm-up & cooling down. Before commencing the experimentation; the researcher explained the nature and importance of the study to the subjects. On the basis of their willingness, they have been included to serve as subjects in this study. At the very outset, the health condition of all the subjects were checked up by an expert physician and on the recommendation of the medical practitioner those athletes who were declared as 'Fit' to undergo rigorous training program for several weeks, they were confirmed as subjects for the present study.

Table 1: Resistance Training Protocol for 8 Weeks

Name of the Exercise	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
	30% 1RM	30% 1RM	40% 1RM	40% 1RM	50% 1RM	50% 1RM	60% 1RM	60% 1RM
	Sets × Repetitions							
Squat	2×10	2×10	3×8	3×8	3×7	3×7	4×6	4×6
Leg Press	2×10	2×10	3×8	3×8	3×7	3×7	4×6	4×6
Heel Raise	2×10	2×10	3×8	3×8	3×7	3×7	4×6	4×6
Lunge	2×10	2×10	3×8	3×8	4×7	4×7	4×6	4×6
Leg Curl	2×10	2×10	3×8	3×8	3×7	3×7	4×6	4×6
***RM = Repetition maximum**								

Table 2: Plyometric Training Protocol for 8 Weeks

Name of The Exercise	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
	Repetitions × Number of Times							
Jump & Squat	2×8	2×8	2×10	2×10	2×10	2×8	3×6	3×6
Single leg Hop(both)	2×6	2×7	2×8	2×10	2×10	2×8	2×6	2×6
Double leg bounding	2×8	2×8	2×8	2×8	2×8	2×10	2×8	2×8
Split Jump	2×6	2×6	2×8	2×8	2×8	2×6	2×5	2×5
Tuck Jump	2×6	2×6	2×7	2×8	2×8	2×6	2×5	2×5
Box Jump	1×8	1×8	2×6	2×8	2×8	2×6	2×6	2×6
Depth Jump	1×8	1×8	2×6	2×8	2×8	2×6	2×6	2×6
Volume	96	100	122	140	140	116	102	102
Intensity	Low	Low	Medium	Medium	Medium	High	High	High

Table 3: Plyometric Training Protocol for 8 Weeks

Sl. No.	Name of the Group	No. of Subjects	Age (years)	Height (cm.)	Weight (Kg.)
			Mean ± S.D	Mean ± S.D	Mean ± S.D
1	**RTG**	12	16.46 ± 1.98	154.14 ± 6.28	48.07 ± 7.15
2	**PTG**	12	15.98 ± 1.63	158.38 ± 7.44	50.42 ± 6.24
3	**CG**	12	16.05 ± 1.82	155.46 ± 6.78	49.34 ± 7.42
Total No. of Subjects: (N) = 36					

Table 4: Mean, Standard Deviation and Analysis of Co-Variance (ANCOVA) of Speed among RTG, PTG and CG in Baseline, Post Treatment and Adjusted Post Test

Test	RTG	PTG	CG	Source of variance	Sum of squares	df	Mean squares	'F' Ratio
Baseline	6.53 ± 0.29	6.53 ± 0.26	6.51 ± 0.35	Between	0.01	2	0.02	0.017
Mean ± SD ($m.s^{-1}$)				Within	3.01	33	0.09	
Post Treatment	6.72 ± 0.27	6.83 ± 0.37	6.50 ± 0.36	Between	0.66	2	0.33	2.89
Mean ± SD ($m.s^{-1}$)				Within	3.78	33	0.11	
Adjusted post test	6.71	6.82	6.51	Between	0.57	2	0.29	**28.43***
Mean ($m.s^{-1}$)				Within	0.32	32	0.01	
***The table values required for significance at .05 level with df (2,33) and (2,32) were 3.29 and 3.30 respectively**								

Table 5: Tukey's LSD test on Speed in Adjusted Post Test Mean Score for Different Groups

Adjusted Post Test Mean Scores				Required confidence interval
RTG	**PTG**	**CG**	**Mean Difference**	
6.71	6.82		**0.11***	0.083
6.71		6.51	**0.20***	0.083
	6.82	6.51	**0.30***	0.083
Calculated Value of Critical Difference at 0 .05 level of significance with df(32) was 0.083				

Written consent from each subject was taken prior to the commencement of the work where the consent of their guardians was also confirmed.

In resistance training specific resistance faced by an individual during the intervention of training were determined by their maximum load bearing ability in one repetition. In resistance training this ability of an individual is called 1 Repetition Maximum (1-RM). The resistance training was started with 30% of 1 RM load in the first & second weeks. The intensity and the volume were progressively increased after completion of each 2 weeks respectively from 30% to 40% likewise up to 60% 1-RM in seventh & eighth week of training period. The resistance training was consisted of five exercises viz. Squat, Leg Press, Heel Raise, Lunge and Leg Curl. Two to three minute passive recovery was given between each set of exercise. The details of the resistance training have shown in **Table 1**, (Whitehead *et al.*, 2018; Zghal *et al.*, 2019).

Plyometric Training

In plyometric training seven plyometric exercises viz. Jump & Squat, Single leg Hop (Alternate leg), Double leg bounding, Split Jump, Tuck Jump, Box Jump and Depth Jump were sequentially performed by the athletes. The intensity and the volume were progressively increased. Two to three minute passive recovery was given between each set of exercise. The details of the plyometric training have shown in **Table 2**, for evaluating the speed ability of athletes' pre and post-training data were recorded for each group (Biswas & Ghosh, 2019; Whitehead *et al.*, 2018).

Variable Studied

In the present study speed ability was taken as the only dependent variable which was measured through 60 yard dash (Rani, 2018; Bhowmi *et al.*, 2016; Hebbelinck & Postma, 1963; Crotin, 2009).

Statistical analysis

Test-Retest reliability of data was tested by computing co-efficient of correlation. Data normality was tested by Kolmogorov–Smirnov Test. To find out significant difference in speed ability among the groups in the pre and post intervention condition; analysis of covariance

(ANCOVA) was conducted. To find out the exact location of the difference between different groups Tukey's LSD test was adopted as post hoc test. The significance of means were tested at $p<0.05$ level.

Results

In the following sections the descriptive statistics and interpretation of data and results of the study were presented.

In **Table 3,** the mean and standard deviation of age, height, and weight of the subjects for different groups have been presented.

From **Table 4** it was also found that the baseline F-value of speed among the three groups were 0.017 which was less than the required table value 3.29 for significance with df (2,33) at 0.05 level. It signifies that RTG, PTG and CG were exactly equated at baseline.

From **Table 4** it was also found that the post-treatment F-value of speed among the three groups were 2.89 which was also less than the required table value 3.29 for significance with df (2,33) at 0.05 level. It signifies that there was no significant difference among the different groups in post-treatment condition.

It was also evident From **Table 4** that the adjusted post-test F-value of speed among the three groups was 28.43 which was greater than the required table value 3.30 for significance with df (2, 32) at 0.05 level. It signifies that there was a significant difference among three different groups of subjects i.e. RTG, PTG and CG in adjusted post test condition. To locate the exact difference among the groups in speed Tukey's LSD test was used as post hoc test which have presented in **Table 5**. The Pre-test, Post-test and adjusted post test mean value of the RTG, PTG and CG on speed has been presented graphically in **Fig. 2.**

Table 5 represents Tukey's LSD test on speed for Adjusted Post Test Mean Score. The mean difference between RTG & CG was 0.20 which was found significantly greater than the Critical Difference (CD) 0.083 at 0.05 level of significance at df (32). It indicated that speed ability of the resistance training group (RTG) improved significantly in comparison with the CG.

It was also found from Tukey's LSD test that on speed for adjusted post test mean score between PTG & CG, the mean difference i.e. 0.30 which was found greater than the value of Critical Difference (CD) 0.083 at 0.05 level of significance at df (32). It was clear from the mean difference that the speed ability of the PTG improved significantly with respect to CG.

From **Table 5** i.e. from the table of Tukey's LSD test on speed the adjusted post test mean score between RTG & PTG, the mean difference was 0.11 which was found significantly greater than the Critical Difference (CD) 0.083 at 0.05 level of significance at df (32). It indicated that PT had better effect than RT for developing speed ability.

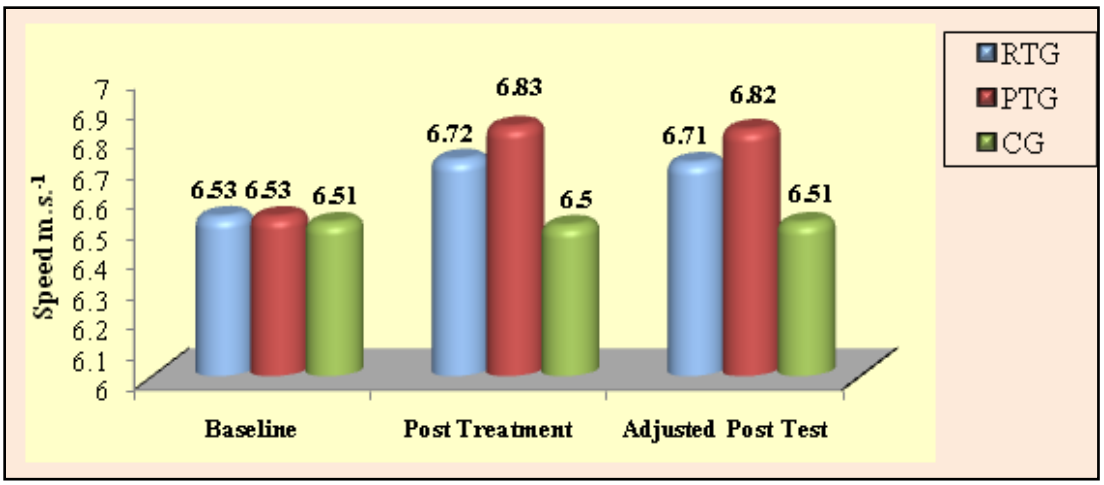

Figure 2: Mean value of speed in baseline, post treatment and adjusted post treatment of two group of subjects

Discussion

The present study was performed to investigate the effectiveness of PT in comparison with RT on speed ability of the athletes. At the end of the 8 week experimentation it was found that both the training group i.e. RTG & PTG led to increases of the speed ability in comparison to CG. Several studies suggested that the improvement of speed ability is possible by both RT and PT (Delecluse, 1997; Fischetti *et al*., 2019; Harries *et al*., 2012; Peitz *et al*., 2018; Whitehead *et al*., 2018; Zghal *et al*., 2019). This result can be explained by the fact that the individuals who perform high-velocity isokinetic or isotonic resistance training have been shown to improve their force production ability during speed performance (Ewing *et al*., 1990; Mannion *et al*., 1995; Smith & Melton, 1981; Wilson *et al*., 1996). This enhancement of increased force production ability may lead to the improvement of speed ability of the RTG in comparison to the CG.

Several studies have suggested that plyometric training may improve speed, because in plyometric training the use of stretch-shortening cycles (SSC) of the flexor and extensor muscle groups have been shown to have significant relationship with short sprint times (Baechle & Earle, 2008; Chu, 1992; Hennessy & Kilty, 2001; Miller *et al*., 2002; Robinson *et al*., 2004). Some researchers were determined that plyometric or SSC loading is higher during depth jump, followed by counter movement jump, and then during squat jumps (Bosco, 1985). Studies reported that plyometric training enhance the maximal force exertion ability of the muscles instantaneously i.e. in very short period of time therefore for those activities that require explosive and powerful movements in a short duration of time it is considered as a very useful method of training (Baechle & Earle, 2008; Kobak *et al*., 2015). The above studies suggested the similar results as obtained in the present study for the development of speed ability in PTG in comparison with CG.

In the present study it was also observed that that PTG had improved better than RTG in speed ability. This result was possibly due to the difference of nature and characteristics of the exercises included in the resistance training & plyometric training protocol. Most of the exercises in the resistance training protocol were performed in low velocity against high resistance. On the other hand in the plyometric training protocol the exercises were involved in explosive muscle contractibility started from eccentric to concentric contraction of muscle produce grater force and power generation. These characteristics of plyometric exercises may influence the speed ability better than the resistance training. As plyometric training consist of frequent jumps with drops from different heights which needs explosive stretch ability of the muscles to adapt rapidly from eccentric to concentric contraction (Arazi & Asadi, 2011; Gehri *et al*., 1998). It is reflected from the results of the present study that systematically designed and scientifically structured plyometric training develops the speed ability of athletes (Biswas & Ghosh, 2019). Some studies demonstrated a decrease in sprint time consequently improved speed ability in pre-pubertal to adolescents soccer players (Sáez de Villarreal *et al*., 2015; Diallo *et al*., 2001; Kotzamanidis, 2006; Meylan & Malatesta, 2009), others have not (Ingle *et al*., 2006; Thomas *et al*., 2009). On the other hand, in resistance training, although improvements in performance after resistance training are most marked for tasks with movement patterns similar to the resistance training exercises themselves, increases in velocity-specific performance have been shown when the testing and training exercises have been different (Delecluse *et al*., 1995; Hoff & Almåsbakk, 1995; Wilson *et al*., 1996). This suggests that resistance training exercises that significantly increase high-velocity force production may improve performance in other power-oriented tasks. It is reasonable to assume, therefore, that speed or power athletes wishing to improve their high-velocity force production should perform resistance training exercises at high movement speed (Blazevich & Jenkins, 2002). Thus it needs further investigation between these two training means by including special resistance exercises that are usually performed in high movement speed. Inclusions of these types of exercises in the resistance training protocol may lead to improve the speed abilities in similar degree as improved in the plyometric training group (PTG) in the present study.

Conclusion

From the above result and discussions of the present study it can be concluded that both the RT and PT significantly improved the speed ability in comparison to CG of the athletes. Thus speed ability can be developed through resistance training as well as through plyometric training. On the other hand significant difference was also found between the subjects of RTG and PTG for improving speed ability where PTG improved better than the RTG. It clearly states that PT had better effect for developing speed ability than RT. So speed ability can be developed better trough plyometric training than resistance training. Thus, it is recommended to choose PT in

place of RT to get better impact for the development of speed ability of the athletes.

Recommendation

In this stage the researchers suggest that though both training types improved speed ability in comparison to the control group, but as better impact was seen in plyometric training, it is advised to choose plyometric training means for the development of speed ability of the athletes. In this context it is also recommended that further investigation is also required to justify the exact impact of resistance training for speed development by including high speed resistance exercises in the resistance training protocol. Possibly, these inclusions of high speed resistance exercises will make the two protocol (PT & RT) equivalent when the development of speed is concern. This research effort may also be extended over the other populations belonging to the speed dominated sports to make the conclusion more generalized.

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