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EFFECTS OF 6 WEEKS PLYOMETRIC EXERCISES V/S RESISTANCE BAND EXERCISES ON PERFORMANCE OF UNIVERSITY LEVEL SPRINTERS: A COMPARATIVE STUDY

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ABSTRACT

Background: Sprinting is running over a short distance at the top-most speed of the body in a limited period of time. Plyometric exercises is defined as a system of high-velocity resistance exercises characterized by a rapid, resisted, eccentric (lengthening) contraction during which the muscle elongates, immediately followed by a rapid reversal of movement with a resisted concentric (shortening) contraction of the same muscle. Resistance band exercises is the most popular and effective form of conditioning aimed at enhancing one's performance in sports, and its use is widespread among high school, college, and professional athletes. The objective is to determine the effects of 6 weeks plyometric exercises versus resistance band exercises on the performance of university level sprinters.

Materials and Methods: A comparative study was conducted on university level sprinters who were selected from the D.A.V.V. University, Indore (M.P.). N=200 sprinters who met the set inclusion-exclusion criteria were included in the comparative study. They were enrolled in the study after giving their informed consent. They were randomized into two Groups: Group A (n=100) plyometric exercises and the Group B (n=100) resistance band exercises. All participants of the study underwent exercise protocol for a duration of 6 weeks . They were then assessed for Pre and Post values of 20 meters sprint test, Illinois agility test, vertical jump height test which were recorded at the beginning and later at the end of the exercise program.

Results: After 6 weeks of exercise protocol, on comparing the results of the two groups there was found a statistically significant improvement in Performance i.e. 20 meter sprint test ($p<0.0001$), Illinois agility test ($p<0.0001$), vertical jump height test ($p<0.0001$). Therefore, it was concluded from the comparative results of the two groups that plyometric exercises was found to be more effective than resistance band exercises in improving performance of university level sprinters.

Conclusion: The study concluded that plyometric exercises was found to be more effective than resistance band exercises in improving performance of university level sprinters.

Keywords: Plyometric exercise, Resistance band exercise, sprinters, 20 meter sprint test, Illinois agility test, vertical jump height test and performance.

INTRODUCTION

Running a short distance at your maximum physical speed in a condensed amount of time is known as sprinting. Biomechanically, sprinters initiate the race by adopting a crouching position in the starting blocks before driving forward and gradually moving

into an upright position as the race progresses and momentum is gained. The use of starting blocks allows the sprinter to perform an enhanced isometric preload; this generates muscular pre-tension which is channelled into the subsequent forward drive, making it more powerful.[1]

Plyometric exercises is defined as a system of high-velocity resistance training characterized by a rapid, resisted, eccentric (lengthening) contraction during which the muscle elongates, immediately followed by a rapid reversal of movement with a resisted concentric (shortening) contraction of the same muscle.[2-5] Plyometric exercise utilizes the stretch-shortening cycle (SSC) by using a lengthening movement (eccentric) which is quickly followed by a shortening movement (concentric).[3,4] Plyometric exercises plays an integral role in performance enhancement regardless the phase it has been used. Plyometric exercises are used in every sport to increase strength and explosiveness of muscles. Plyometric exercises used for performance enhancement of the athlete should match the characteristics of their sporting activity they are involved with. That is, to optimize the activity by the principle of specificity. For example, only jumping specific exercises will not increase the running speed. Plyometric exercises is a type of exercises which have the ability to develop force at high speed in dynamic movements. These dynamic movements includes the stretch of muscle immediately followed by an explosive contraction of the muscle.[6-8]

Plyometric exercise includes activities such as jumping, hopping, skipping and bounding. This exercises are a popular exercise for improving the performance of various athletic activities, including those using sprinting. One meta-analysis revealed a moderate effect of plyometric training on sprint performance in healthy adults.[1,2] Moreover, sprint time was also significantly reduced after plyometric exercises in youth players. In male adults sprinters, two weeks of plyometric exercises decreased a sprint time was significantly noted.[9] There are previous studies that have established the effectiveness of plyometric exercises in improving power and performance in the lower extremities. Evidence for the use of plyometric exercises in the lower extremities is available with regard to enhancement of performance in uninjured subjects and also in those with injury or previous injury. Numerous authors have described increased jump height, sprint time reduction, improved running speed and improved joint position sense and postural control as a result of Lower extremity plyometric exercises.

This rapid deceleration-acceleration produces an explosive reaction that increases both speed and power of the limb during athletic activities. This explosive reaction facilitates the production of maxi mal force in the shortest amount of time. Plyometric training is often considered the missing link between strength and return to performance.

The effects of plyometric exercises for sprint-specific programs appear to be the greatest over initial portion of a sprint (10-40 m) as compared to longer distances (>40 m). These results suggest that sports participants who are accustomed to sprints over distances of 40 m could still improve times by improving in the initial acceleration phase of sprinting, by adding plyometric exercises to their program.

Resistance exercises is a type of exercise whereby external weights utilized provide progressive overload to skeletal muscles in order to make them stronger and often result in hypertrophy18. Resistance exercise is the most popular and effective form of conditioning aimed at enhancing one's performance in sports, and its use is widespread among high school, college, and professional athletes.[8] The positive effects of a sound resistance exercise regime on increase in strength in adult athletes have been widely documented in the literature. There is evidence that indicates that resistance training is not only a relatively safe activity for young athletes but that it may also be useful to reduce injuries during competitive play. Exercise using resistance bands is an alternative to weight training using rubber or elastic cables as resistance. The combination of resistance band exercises is very effectively used to increase jump height and leg strength, increase speed, and agility.[7-13] Previously, resistance bands have been used primarily in rehabilitation settings for exclusive sport-specific objectives, such as improving strength and power in various sports.

Elastic resistance bands may be effective tools for enhancing the concentric portion of an exercise by facilitating certain aspects of the eccentric phase (i.e. muscle activity, eccentric impulse, and the rate of loading). It is simply the recoil of the elastic bands which may enhance these aspects of the eccentric phase, as it provides an assistive/accelerative component to the movement. Resistance band exercises as a form of loading can increase muscle strength, balance, agility and activate the sensorimotor system through peripheral stimulation, muscle coordination, and neuromuscular adaptation.[14,15]

Objective

To determine the effects of 6 weeks plyometric exercises versus resistance band exercises on the performance of university level sprinters.

MATERIALS AND METHODS

Study design: A Comparative approach

Study participants: University Level Sprinters

Place of study: The study was conducted at Athletics Arena, Devi Ahilya Vishwavidyalaya (D.A.V.V.) University, Indore (M.P.) & Department of Physiotherapy, A unit of MAHSI, M.Y. hospital and M.G.M. Medical College, Indore (M.P.)

Study duration: The study was conducted for a period of 12 months.

Sample size: 200 university sprinters were selected according to the set inclusion exclusion criteria out of

the 218 chosen sprinters, for the present study. They were randomized into two groups of n = 100 sprinters each. Group A was trained with Plyometric Exercises, while Group B was trained with Resistance Band Exercises.

Sampling method: Purposive sampling method

Ethical consideration: Ethics and Scientific Review Committee, M.G.M. Medical College & M.Y. Hospital, Indore have approved thesis protocol with letter no. EC/MGM/March-23/11.

Selection criteria:

Inclusion criteria:

1. Age group of 18– 25 years
2. Gender – male & female sprinters
3. Atleast 6 months of university level sprinting
4. Doing training sessions of 2 hrs x 5days in a week

Exclusion criteria:

1. Sprinters having recent soft tissue Injuries of lower limb and fracture (muscle strains, ligaments, sprain, Tendonitis).
2. Sprinters having any congenital /acquired abnormalities, mechanical pain.
3. Sprinters having Arthroscopic / Reconstruction surgery of lower limbs.
4. Any history of medication/systemic illness.

Variables in the study: Independent variables: Plyometric Exercises, Resistance Band Exercises. Dependent variables: 20-m Sprint Test, Illinois Agility Test (IAT), Vertical Jump Test (VJHT)

Measuring tool: Measuring tape, Cones, Stop watch, Resistance Band

Outcome measure: 20 meter sprint test: Speed tests are typically used solely to measure an athlete's linear speed capabilities. Track sprinters have been shown to accelerate continuously through at least 50m during a 100m sprint event. it has been suggested they may achieve maximum speeds within far shorter distances – perhaps as short as ≤ 21m. The objective of this test is to monitor the development of the athlete's acceleration and speed.[12,14]

Illinois agility test (IAT): The Illinois Agility Test (IAT) is test used to assess agility. Agility is one of the testing components of performance analysis. Agility may "be defined as the ability to alter direction to achieve a specific goal8. Agility training is often associated with athletics as it is seen as an important component in improving athletic performance.[11] The objective of the Illinois Agility Run Test is to monitor the development of the athlete's speed and agility.

Vertical jump height test (VJHT): The objective of this test is to monitor the development of the athlete's power of the lower body.[14]

Vertical jump score = maximum jump reach - standing reach height

Procedure

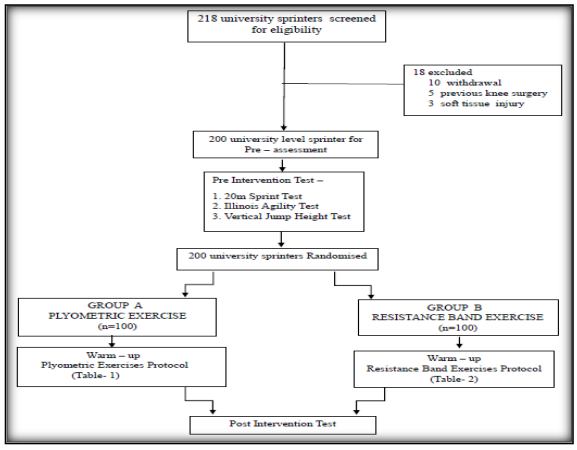


Figure 1: single leg tuck jump

Figure 2: Double leg speed jump

Figure 3: split scissor jump

Figure 4: double leg bound jump

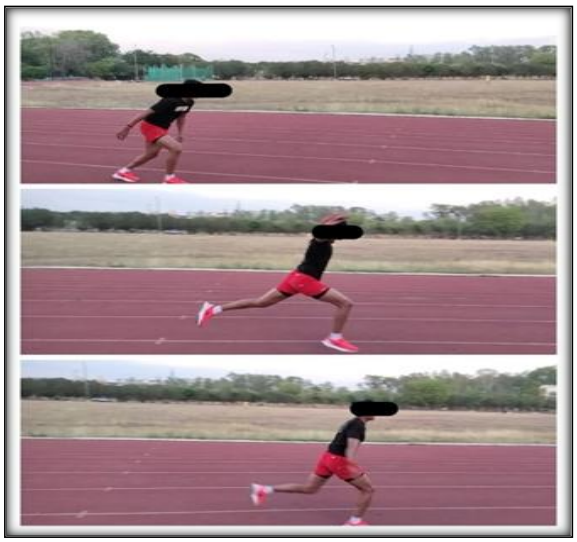


Figure 5: single leg hop jump

Figure 6: double leg tuck jump

Figure 7: clampshell with resistance band

Figure 8: hip flexion with resistance band

Table 1: 6 Weeks Plyometric Exercise Program For Group A

Week	Exercise	Reps.	Sets	Time
Ist week	Double leg tuck jump	10 reps	2 sets	3 days/week
	Double leg speed jump	10 reps	2 sets	3 days/week
	Squat jump	10 reps	2 sets	3 days/week
IInd week	Double leg tuck jump	10 reps	2 sets	3 days/week
	Double leg speed jump	10 reps	2 sets	3 days/week
	Single leg tuck jump	10 reps	2 sets	3 days/week
IIIrd week	Double leg bound	10 reps	2 sets	3 days/week
	Single leg hop	10 reps	2 sets	3 days/week
	Single leg tuck jump	10 reps	2 sets	3 days/week
IVth week	Alternate leg bound	10 reps	2 sets	3 days/week
	Double leg bound	10 reps	2 sets	3 days/week
	Single leg hop	10 reps	2 sets	3 days/week
Vth week	Alternate leg stair bound	10 reps	2 sets	3 days/week
	Single leg speed hop	10 reps	2 sets	3 days/week
	Alternate leg bound	10 reps	2 sets	3 days/week
VIth week	Split scissor jump	10 reps	2 sets	3 days/week
	Alternate leg stair bound	10 reps	2 sets	3 days/week
	Single leg speed hop	10 reps	2 sets	3 days/week

Table 2: 6 Weeks Resistance Band Exercise Program For Group B-

Exercise	Frequency x sets						Time
	Ist Week	IInd Week	IIIrd week	IVth week	V th week	VIth week	
Ankle dorsiflexion & plantarflexion with resistance band	10reps x1sets	10reps x2 sets	10reps x3 sets	10reps x4 sets	10reps x5 sets	10reps x6 sets	3 Days/week
Hamstring curl with resistance band	10reps x 1sets	10reps x 2 sets	10reps x3 sets	10reps x4 sets	10reps x5 sets	10reps x6 sets	3 Days/week
Knee extension with resistance band	10reps x1sets	10reps x2 sets	10reps x3 sets	10reps x4 sets	10reps x5 sets	10reps x6 sets	3 Days/week
Clampshell with resistance band	10reps x1sets	10reps x2 sets	10reps x3 sets	10reps x4 sets	10reps x5 sets	10reps x6 sets	3 Days/week
Leg extension with resistance band	10reps x1sets	10reps x2 sets	10reps x3 sets	10reps x4 sets	10reps x5 sets	10reps x6 sets	3 Days/week
Standing hip flexion with resistance band	10reps x1sets	10reps x2 sets	10reps x3 sets	10reps x4 sets	10reps x5 sets	10reps x6 sets	3 Days/week

RESULTS

In the study, out of 218 university sprinters, n=200 university sprinters following inclusion criteria, table 3 illustrates 163 sprinters were boys (81.5%) and remaining 37 were female sprinters (18.5%). Out of 100 sprinters in each group, Group A has 78 male sprinters and 22 female sprinters whereas, Group B has 85 male sprinters and 15 female sprinters. Table 4 illustrates the mean and standard deviation of group A is 21.91 and 1.90. The mean and standard deviation of group B is 21.48 and 2.08. Table 5 illustrates the average mean of Pre and Post test 20-m sprint test of Group A are 3.75±0.24 and 3.71±0.24 and Group B are 3.76±0.07 and 3.75±0.07 respectively. The p-value between the pre test and post-test of the two groups are 0.003 and less than 0.0001, respectively. Table 6 illustrates the average mean of Pre and Post test Illinois agility test of Group A are 17.39±0.76 and 17.22±0.87 and Group B are 17.82±0.73 and 17.76±0.71 respectively. The p value between the pre-test and post-test of the two groups are 0.0001 and 0.0001, respectively. Table 7 illustrates the average mean of Pre and Post test Vertical Jump Height test of Group A are 48.14±3.56 and 51.03±3.68 and Group B are 48.64±2.99 and 49.95±2.92 respectively. The p-value between the pre-test and post-test of the two groups are 0.624 and 0.0001, respectively. Hence, there is a significant difference in comparative effects of plyometric exercises and resistance band exercises on 20-m sprint time, Illinois agility test and vertical jump height test values between Group A & Group B

Table 3: Gender distribution in each Groups -shows the total count and percentage of male & female sprinters in both Groups

Sex	Group A	Group B	Total
Male sprinter	78 (78%)	85 (85%)	163 (81.5%)
Female sprinter	22 (22%)	15 (15%)	37 (18.5%)
Total	100 (100%)	100 (100%)	200(100.0%)

Table 4: Mean and Standard deviation of age of patients in Group A & Group B

Variable	Groups	Mean	Standard Deviation
Age	Group A	21.91	1.90
	Group B	21.48	2.08

Table 5: 20m Sprint Test (sec.)- Pre Test & Post Test Values

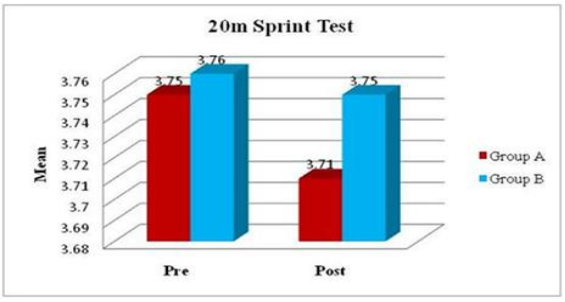
20 metres sprint test (sec.)	Group	N	Mean±SD	Mann-Whitney U test	p-value
Pre	Group A	100	3.75±0.24	3768.00	0.003
	Group B	100	3.76±0.07		
Post	Group A	100	3.71±0.24	2979.500	<0.0001
	Group B	100	3.75±0.07		

Table 6: Illinois Agility Test (sec.) – Pre Test & Post Test Values

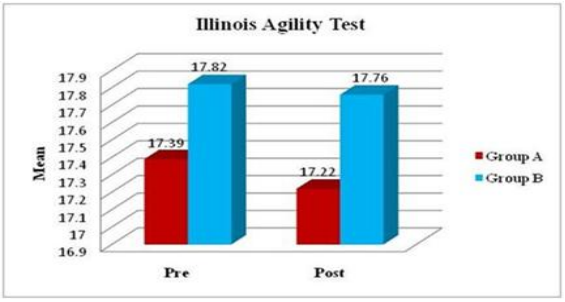
Illinois agility test (sec.)	Group	N	Mean ± SD	Mann-Whitney U test	p-value
Pre	Group A	100	17.39±0.76	3321.00	<0.0001
	Group B	100	17.82±0.73		
Post	Group A	100	17.22±0.87	2997.00	<0.0001
	Group B	100	17.76±0.71		

Table 7: Vertical Jump Height Test (cm.)- Pre Test & Post Test Values

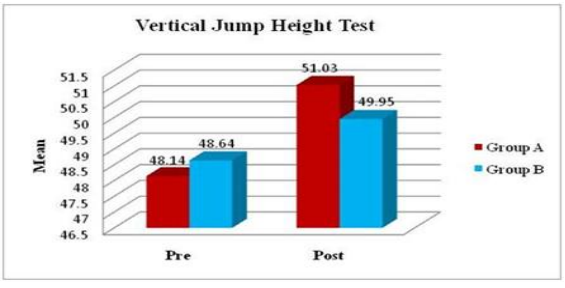
Vertical jump height test (cm)	Group	N	Mean ± SD	Mann-Whitney U test	p-value
Pre	Group A	100	48.14±3.56	4802.00	0.624
	Group B	100	48.64±2.99		
Post	Group A	100	51.03±3.68	3469	<0.0001
	Group B	100	49.95±2.92		



Graph 1: Show average mean Pre and Post values of 20m sprint test between Group A & B.



Graph 2: Show average mean Pre and Post values of Illinois agility test between group A & B.



Graph 3: Show average mean Pre and Post values of Vertical jump height test between group A & B.

DISCUSSION

Comparison between Plyometric exercises (group A) and Resistance band exercises (group B) revealed better trends of improvement in the Plyometric exercises group than Resistance band group.

Evidences suggesting the effectiveness of Plyometric exercises have been found in various studies. study done by Singh A., Shenoy S. et al. 2019 highlights and suggests the benefits of 6 weeks plyometric training in improving agility, vertical jump height, balance and 20 meters sprint test. In addition of plyometric combined with sprint training seemed mostly to augment gains in overall performance.[10] In another study Paes PP, Correia GA, Damasceno VD et al. 2022 Plyometric exercises program lasting six weeks promotes significant improvements in 20 meters sprint test and Illinois agility test.[16] Rimmer E, Sleivert G. 2000 the plyometrics intervention appears to have had the greatest effect on sprint performance in the initial acceleration phase.[6] Plyometric exercises , with its greater emphasis on power development but lesser specificity, was equally as effective as the sprint training with its greater specificity but lesser potential for power development.[6,17,18]

Potential mechanisms for improvements in sprint performance include changes in temporal sequencing of muscle activation for more efficient movement, preferential recruitment of fastest motor units, increased nerve conduction velocity, a frequency or degree of muscle recruitment and rapid firing throughout the sprint Ross et al, 2001.[19] Several previous studies have suggested that plyometric training can enhance sprinting ability just because it is based on the use of Stretch Shortening Cycle,de Villarreal et al., 2008.

Improvements in agility can occur in as little as 6 weeks of plyometric exercises which can be useful during the last preparatory phase before in-season competition for sprinters, Miller MG, Herniman JJ, Ricard MD 2006.[11] Study concluded the benefits plyometric exercises can have on agility. Not only can athletes use plyometric exercises to break the monotony of training, but they can also improve their strength and explosiveness while working to become more agile. Jastrzbeski Z, Wnorowski K., Mikolajewski R. et al. 2014, plyometric exercises are standard and easy to perform in various conditions, six weeks plyometric exercises regime develops the explosive power more effectively.[17] Sa ´ez de Villarreal E, Requena B. and Cronin J.B. 2012 in their meta-analysis, plyometric exercises significantly improves sprint performance. The reported sprint time gains of >-0.081 seconds resulting from plyometric exercises could be of practical relevance for trained athletes in sports i.e. Short distance sprint.[2]

Some authors explain that the gains that can be made via plyometric exercises are dependent on training status. Athletes, such as sprinters, who require power for moving in the horizontal plane engage in bounding plyometric exercises. The higher improvements in sprint performance may be because of a training specificity. It is possible that a exercise program incorporating more horizontal acceleration (eg. Bounding) may improve sprint times. Volume and frequency are very important parameters to be taken into account for an optimum plyometric exercise program design.[1,2] The sprint performance gains will be optimized by the use of training programs that incorporates greater horizontal acceleration (ie. Sprint specific plyometric exercises, jumps with horizontal displacement).

Some authors stated that resistance band exercises, the exercise program that causes muscles to contract against external loads in the hope of increasing strength, endurance and power. Today, the resistance band exercises less considered as compared to plyometric exercises for improvement of sport performance. Reason behind this is advancement of new technique. Resistance band exercises improve strength and power not that much as compare to plyometric exercises. Resistance bands produce a spring force which does not rely on gravity. These bands only induce muscular contraction.[20]

The above reasons support the results of the study indicating that Plyometric exercises are more effective in improvement of Performance of university level sprinters.

CONCLUSION

There was a statistically significant difference in both groups – group A (plyometric exercises) and group B (resistance band exercises). The results of the present study support the effectiveness of Plyometric exercises over Resistance band exercises on performance of university level sprinters. The statistical analysis suggested that performance parameters like 20 meters sprint test, Illinois agility test and Vertical jump height test were significantly improved when Plyometric exercises and Resistance band exercises was practiced for 6 weeks by university level sprinters.

These findings depict that the plyometric exercises are effective in improving the lower limb muscle strength and sprint time of university level sprinters and thus, can be incorporated into the regular training programs of sprinters to improve the performance and reduce the risk of injury.

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