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An assessment study of effects of strength training and plyometric training on elastic power

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Abstract
The aim of the study was to find out the effects of strength training and plyometric training on elastic power. To achieve this purpose of the study, forty five female students studying in the Department of Physical Education, C.C.S. University, Meerut, Uttar Pradesh were selected as subjects at random. Their age ranged between 18 to 24 years. The selected subjects were divided into three equal groups of fifteen each namely strength training group, plyometric group and control group. The Experimental Group I underwent Strength Training, Group II underwent Plyometric Training for three days per week for twelve weeks whereas the Control Group (Group III) maintained their daily routine activities and no special training was given to them. The following variable namely elastic power was selected as criterion variable. The subjects of the three groups were tested on elastic power using bunny hops at prior and immediately after the training period. The collected data were analyzed statistically through analysis of covariance (ANCOVA) to fund out the significant difference, if any among the groups. Whenever the obtained "F" ratio was found to be significant, the Scheffe's test was applied as post hoc test to find out the paired mean difference, if any. The 0.5 level of confidence was fixed to test the level of significance which was considered as an appropriate. The results of the study showed that there was a significant difference exist among strength training group, plyometric training group and control group on elastic power. And also strength training group and plyometric training group showed significant improvement on elastic power when compared to control group.

Keywords: Strength training, plyometric training, elastic power, analysis of covariance, ANCOVA

Introduction
Sports training is of vital importance for several fields of human activity i.e. performance sports, fitness, leisure and recreation sports, rehabilitation and physical education etc. It primarily deals with the laws, rules and principles of improving the sports performance capacity of human beings.

Sports today is highly competitive. There is a very thin margin between a winner and a looser. It is, hence, each and every aspect of training in sports that is important for successful participation in the competitive sports.

All the disciplines of sports sciences have their own areas of study which in all cases is a certain aspect of sports performance and sports training. Sports training basically studies sports performance in totality, rather than just one aspect of the whole. This discipline carries the most important responsibility of creating knowledge and assimilating and collecting knowledge from all sports disciplines and on its basis to formulate theories, principles etc., to determine how the sports training should be planned, organized, implemented and regulated.

"Sports training can be defined as a pedagogical process, based on scientific principles, aiming at preparing sports persons and non-sports persons to strive for higher performances in sports competitions and attain the best possible fitness"

Scope of sports training
The complex nature of sports training involving physical exercises along with other means becomes obvious when one looks at the training of advance sports persons. The training of advanced sports persons is significantly supported by means and measures from several sports science disciplines e.g. sports medicine, sports physiology, nutrition, sports physiotherapy, sports psychology, sports bio-mechanics and so on.

Important characteristics of the sports training

- It is a combination of fun and serious activities for successful participation.
- It involves pre-planned schedules and a systematic and scientific approach.
- It involves dedication and a pragmatic approach on the part of the trainer or coach.
- Sports training involves identification of talent and exploiting the talented to achieve the best.
- It is flexible as well as rigid.
- Sports training is not just physical exercise but the development of the sports person as a whole.
- It is a continuous process of perfection, improvement and creation of means and methods of improving sports performance and factors of performance.

Objectives of sports training

Sports training aims at improving the performance of sports persons. The performance of a sports person depends on his performance capacity, which is a complex of five groups of factors:

Physical fitness or condition

Physical fitness is a sum total of five motor abilities namely: strength, speed, endurance, flexibility and co-coordinative abilities. Each sport requires a different type and level of physical condition called sport specific fitness. Thus sports training aims to improve this sport specific fitness.

Technical skill

In sports in which only one or two simple movements have to be learnt the role of technical skills is less as compared to the games like gymnastics and basketball, where one may have to perform more than one technical skill. The acquisition of sports specific technical skills, therefore, is an important aim of sports training.

Tactical efficiency

It is important to improve the sports person's tactical abilities and tactical skills for him to be able to perform better. Sports training aims at the development of tactical efficiency at high levels of sports competitions and its volume increases for the sports persons who have reached a considerable level of technical skill. It is an integral part of training in team games, combat sports and the racket sports.

Principles of sports training

There are several universally accepted scientific training principles that must be followed in order to improve conditioning and sports performance. These principles include:

1. The Principle of Individual Differences
2. The Principle of Overload
3. The Principle of Progression
4. The Principle of Adaptation
5. The Principle of Use/Disuse
6. The Principle of Specificity

The principle of individual differences

Because every athlete is different, each person's response to exercise will vary. A proper training program should be modified to take individual differences into account. Some considerations:

- Large muscles heal slower than smaller muscles.
- Fast or explosive movements require more recovery time than slow movements.
- Fast twitch muscle fibers recover quicker than slow twitch muscle fibers.
- Women generally need more recovery time than men.
- Older athletes generally need more recovery time than younger athletes.
- The heavier the load lifted, the longer it will take the muscles to recover.

These are just some of the many differences in athletes. All of these differences will factor into an athlete's training routine. Coaches should also be aware of these differences, and not expect all the athletes on a team to perform the exact same routines.

The principle of overload

The principle of overload states that a greater than normal stress or load on the body is required for training adaptation to take place. The body will adapt to this stimulus. Once the body has adapted then a different stimulus is required to continue the change. In order for a muscle (including the heart) to increase strength, it must be gradually stressed by working against a load greater than it is used to. To increase endurance, muscles must work for a longer period of time than they are used to. If this stress is removed or decreased there will be a decrease in that particular component of fitness. A normal amount of exercise will maintain the current fitness level.

The principle of progression

The principle of progression implies that there is an optimal level of overload that should be achieved, and an optimal timeframe for this overload to occur.

- Overload should not be increased too slowly or improvement is unlikely.
- Overload that is increased too rapidly will result in injury or muscle damage.
- Beginners can exercise progressively by starting near threshold levels and gradually increasing in frequency, intensity, and time within the target zone.

Exercising above the target zone is counterproductive and can be dangerous. For example, the weekend athlete who exercises vigorously only on weekends does not exercise often enough, and so violates the principle of progression.

Many people, who consider themselves to be regular exercisers, violate the principle of progression by failing to exercise above threshold levels and in the exercise target zone. Clearly, it is possible to do too little and too much exercise to develop optimal fitness.

The Principle of Progression also makes us realize the need for proper rest and recovery. Continual stress on the body and constant overload with result in exhaustion and injury. You should not (and cannot) train hard all the time. Doing so will lead to overtraining and a great deal of physical and psychological damage will result.

The principle of adaptation

The body adapts to stress in a highly specific way. Adaptation is the way the body 'programs' muscles to remember particular activities, movements or skills. By repeating that skill or activity, the body adapts to the stress and the skill becomes easier to perform. Adaptation explains why a beginning exercisers are often sore after starting a new routine, but after doing the same exercise for weeks and

months the athlete has little, if any, muscle soreness. This also explains the need to vary the routine and continue to apply the Overload Principle if continued improvement is desired.
The levels of adaptation are quite complex. A more detailed explanation can be read here.

The principle of use/disuse
Once you understand the Principle of Adaptation, you understand the need for rest. However, how much rest is enough and how much is too much? The Principle of Use/Disuse implies that you "use it or lose it." This simply means that your muscles hypertrophy with use and atrophy with disuse. The main problem here is finding the correct balance between stress and rest on the muscles. There must be periods of low intensity between periods of high intensity to allow for recovery. The periods of lower intensity training, or the rest phase, is a prime time for a bit of cross training. Cross training allows you to let over stressed muscle groups rest and recover, while still providing cardiovascular conditioning and providing muscle balance by working the muscles that aren't as integral to your sport.

The principle of specificity
Related to the principle of adaptation is the principle of specificity. Because the body will adapt in a highly specific way to the training it receives, a strong athletic foundation is needed before specific training methods will work optimally. The Specificity Principle simply states that for these reasons, training must go from highly general training to highly specific training. For example, if you are a sprinter, you may start out with easy running and general strength training before moving on to explosive training in the way of plyometrics or sprinting out of the blocks. If you try to do explosive, high intensity training too soon, you will run the risk of such training being ineffective and possibly resulting in injury. The principle of Specificity also implies that to become better at a particular exercise or skill, you must perform that exercise or skill. To be a good cyclist, you must cycle. The point to take away is that a runner should train by running and a swimmer should train by swimming. There are, however, some great reasons to cross train, as discussed previously.
These 6 are the cornerstone of all effective training methods. These cover all aspects of a solid foundation of athletic training. Once put together, the most logical training program involves a periodized approach which cycles the intensity and training objectives. The training must be specific not only to the sport, but to your individual abilities (tolerance to training stress, recoverability, outside obligations, etc.). The training loads must be increased over time (allowing some workouts to be less intense than others) and must train often enough not only to keep a detraining effect from happening, but to also force an adaptation.
Physical fitness refers to the organic fitness of the individual to perform a daily task with vigorous their by implying the degree of fitness one has to maintain his life with reserved energy. Training is a systematic process of repetitive progressive exercise of work involving learning and acclimatization. Training is the net summation of adaptations induced by regular exercise. Students on the exercises with reference to fitness state that it enables the tolerate more effectively, subsequently stresses of similar nature. The process of stressing the sports-man and his adaptation to these stress is called sports training and it is the mean by which sports performance is improved. Strength training is the use of resistance to muscular contraction to build the strength, anaerobic endurance, and size of skeletal muscles. There are many different methods of strength training, the most common being the use of gravity or elastic/hydraulic forces to oppose muscle contraction. See the resistance training article for information about elastic /hydraulic training, but note that the terms "strength training" and "resistance training" are often used interchangeably.

Methodology
The aim of the present study was to find out the effects of strength training and plyometric training on elastic power. To achieve this purpose of the study, forty five female students studying in the Department of Physical Education, C.C.S. University, Meerut, Uttar Pradesh were selected as subjects at random. Their age ranged between 18 to 24 years. The selected subjects were divided into three equal groups of fifteen each namely Strength Training Group, Plyometric Training Group and Control Group. The Experimental Group I underwent strength training, Group II underwent plyometric training for three days per week for twelve weeks whereas the Control Group (Group IV) maintained their daily routine activities and no special training was given to them. The following variable namely elastic power was selected as criterion variable.
The subjects of the three groups were tested on elastic power using bunny hops at prior and immediately after the training period. The collected data were analyzed statistically through analysis of covariance (ANCOVA) to find out the significant difference, if any among the groups. Whenever the obtained "F" ratio was found to be significant, the Scheffe's test was applied as post hoc test to find out the paired mean difference, if any. The .05 level of confidence was fixed to test the level of significance which was considered as an appropriate.

Training programme
During the training period, the Group I underwent strength training, and Group II underwent plyometric training for three days per week (alternative days) for twelve weeks. Every day the workout lasted for 45 to 60 minutes approximately including warming up and warming down periods. Group III acted as Control who did not participate in any strenuous physical exercises and specific training throughout the training period. However, they performed activities as per their curriculum.

Analysis of data
The analysis of covariance on elastic power of Strength Training Group, Plyometric Training Group and Control Group have been analyzed and presented below.

Elastic power
The analysis of covariance on elastic power of the pre and post test scores of Strength Training Group, Plyometric Training Group and Control Group have been analyzed and presented in Table 1.

Table 1: Analysis of covariance of the data on elastic power of pre and post tests scores of strength training, plyometric training and control groups

Test	Strength training group	Plyometric training group	Control group	Source of variance	Sum of squares	df	Mean squares	Obtained 'F' ratio
Pre test								
Mean	10.71	10.68	10.70	Between	0.006	2	0.003	
S.D. Post Test	1.10	1.12	1.09	Within	0.66	42	0.0157	0.058
Mean	10.82	10.79	10.71	Between	0.989	2	0.445	
S.D. Adjusted Post test	1.08	0.99	1.08	Within	1.69	42	0.04	11.125*
Mean	10.80	10.81	10.70	Between	0.762	2	0.381	9.645*
				Within	1.62	41	0.0395	

*Significant at .05 level of confidence.

The table values required for significance at .05 level of confidence for 2 and 42 and 2 and 41 are 3.222 and 3.226 respectively

The adjusted post-test means of strength training group, plyometric training group and control group on elastic power are 10.80, 10.81 and 10.70 respectively. The obtained "F" ratio of 9.645 for adjusted post-test means is greater than the table value of 3.226 for df 2 and 41 required for significance at .05 level of confidence on elastic power. Since, three groups were compared whenever the obtained "F" ratio for the adjusted post-test was found to be significant, the Scheffe's test was applied as post hoc test to find out the Parired mean differences, if any and it was presented in Table 2.

Table 2: The Scheffe's test for the differences between paired means on elastic power

Strength training group	Plyometric training group	Control group	Mean differences	Confidence interval value
10.80	10.81	-	0.01	0.03
10.80	-	10.70	0.10*	0.03
-	10.81	10.70	0.11*	0.03

*Significant at .05 level of confidence

The Table 2 showed that the mean difference values between strength training group control group, plyometric training group and control group on elastic power were 0.10 and 0.06 respectively which were greater than the required confidence interval value 0.03. And also the mean difference value between strength training group and plyometric training group on elastic power 0.01 which was lesser than the required confidence interval value 0.03 for significance. The results of the study showed that there was a significant difference between strength training group control group, plyometric training group and control group on elastic power. And also it showed that there was no significant difference between strength training group and plyometric training group on elastic power.

Results and Discussion

Based on the results of the study, the following conclusions were made, the results of the study showed that there was a significant difference among strength training group, plyometric training and control group on elastic power. And also it was showed that there was a significant improvement on elastic power due to strength training group, plyometric training. Plyometric training group was better than strength training group. The results of the study are in correlated with the results of Bobber, Cheng and Fetcher which they resulted the significant improvement on selected criterion variables due to strength and plyometric training.

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