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# Plyometric training and linear periodization on lower limb muscle strength in athletes

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**Abstract**
The study is to determine the effect of plyometric training and linear periodization on lower limb muscle strength in athletes.
**Introduction**: The study were to evaluate the effect of plyometric training and linear periodization on lower limb strength improvement in athletes. Sports are intermittently characterized by repeated high-intensity efforts in upper and the lower body during competitions such as Jumping, sprinting, hitting, blocking and throwing a ball are fundamental skills for participation in overhead sports for both adult and adolescent players. Especially for the adolescent athlete, to maintain a successful athletic lifestyle, players must develop physical fitness in multiple dimensions, including anaerobic power, upper and lower body power and agility. Therefore, identifying the training interventions that can be more effective in improving sport-specific performance in athletes.
**Methodology**: The study duration was six weeks of three session per week. The subjects were selected based on the inclusion criteria with age group between 18-24 years male athletes. A total of 30 subjects were recruited and divided into two groups. Group A consist of 15 subjects, who were trained with plyometric training & Group B consist of 15 subjects, who were trained with linear periodization. Outcomes measure were quadriceps and hamstring muscle strength using push pull dynamometer. Pre test and Post test measurement were taken.
**Results:** On comparing Pre test and Post test within and between Group A & Group B on Maximum Voluntary Isometric Contraction (MVIC) of Quadriceps and Hamstrings muscle strength shows highly significant difference in mean values at $P \leq 0.05$.

**Keywords:** Plyometric training, linear periodization, muscle strength

## Introduction
Plyometric training also known as jump training. For the lower body this involves application of jump, hopping and bounding training [1] In which muscles exert maximum force in short intervals of times with the goal of increasing strength. This exercise have been treated including neuromuscular adaptation from a muscle extension to contraction in rapid manner, elastic property and of the major muscles and Golgi tendon organs [2]. Plyometric exercise are implement in various form depending on the purpose of the training program. Typical plyometric exercise include Counter Movement Jump (CMJ), the Drop Jump (DJ) and the Squat Jump (SJ) [3]. These exercise can either be combined within a training program or can be applied independently [4]. Plyometric training utilizes the Stretch-Shortening Cycle (SSC) by using a lengthening movement (eccentric) which is quickly followed by a Shortening movement (concentric) [6]. These are in plyometric activities in the lowed limb, such as running, jumping & kicking. The angular velocities of the knee have been recorded at around 1000 degree/second with each foot contact there is an eccentric stretch followed by the concentric shortening contraction [7]. Linear periodization is a relevant tool in designing an exercise program. For regular strength training practitioners [8].Among the periodization models, there is a classical linear periodization which divides a strength training program into different cycles, macrocycles, mesocycle & micro cycles gradually increasing the training intensity while decreasing the training volume within the between two cycle [9].To gain this competitive edge most coaches Strive to implement some form of planning for training their athletes(10)for Strength & Co-ordination professionals, periodization has become the most effective way to train athletes. Most strength and conditioning professional tend to work with

younger athletes as there are limited opportunity to work at the professional level [11].The coaches find themselves working with high school or more predominately with college athletes [12].College athletes wide range of skill, strength and experience; which can make it difficult to pick a periodization mode that fits each athlete and team [14].As a strength and conditioning professional, it is important to understand the level of skill and strength an athlete has in order to train properly [15].

The goal of a periodization program is to optimize the principle of overload, the process by which the neuromuscular system adapts to unaccustomed loads or stress. For the neuromuscular system to adapt maximally to the training load of stress, it is important to alter training volume and intensity as demonstrated by the body of research comparing periodized programs to non-periodization programs. Faced with increased demand the neuromuscular system adapts with increases in muscular strength. The above program may place consider stress on the neuromuscular system because of the rapid and continuous change in a program variables. It is this stress theoretically makes the program. Effective in eliciting increased amount of strength gain or in aiding athletes to overcome staleness in their training linear periodization has been hypothesized to improve athletic performance more than non-periodization programs. Athlete become more. As advancement in their training methods. As most athletes become stronger and more skilled they require more extensive training protocols. There are different in the duration of the competition among different team sports and that necessitate different periodization schedules. Strength training with the objective of increasing health, physical fitness and life span among the benefits are increases in strength, power, muscular endurance, and fat-free mass. These improvements in physical fitness can be achieved through. Variations in prescription patterns, such as weekly frequency number of series, exercises and repetitions, rest between series and exercises, movement velocity, and joint angle. In this sense, the importance of prescribing exercise systematically and individually has grown, considering all the variables inherent to this process. The aim of periodization includes maximizing the overload principle and allowing a better relation between stress/recovery. Strength training periodization is a tool in designing an exercise program for regular strength training practitioners. Muscle strength in different positions of the knee joint is an important factor in evaluating the joint in rehabilitation settings. Most of the published articles used hand-held dynamometer and manual muscle testing to evaluate the muscle strength of the knee joint; quadriceps and hamstrings in particular. The Push/Pull Dynamometer (PPD) is a hand-held dynamometer, which has gained popularity in measuring muscle strength in clinical practice because of its simplicity and objectivity. Clinically, PPD is a widely used tool for measuring muscle and has been found to correlate with isokinetic strength scores. Among the most common with the sporting population, are injuries to the hamstring muscles, a muscle tendon complex formed of different muscles (semitendinosus, semimembranosus and biceps femoris), that act together and that present a high injury rate in sports that require maximum sprints, blows or ball throws, accelerations and direction changes. The most common injury in this muscle group often occurs during the quick extension of the knee, which requires an eccentric action of the hamstrings followed by a deceleration of the leg at the end of the swinging phase in the running technique cycle. Various studies affirm that the risk of injury on a weakened muscle may increase during these eccentric contractions. The ratio of the peak torque of the hamstrings and quadriceps has been shown to be one of the most reliable indicators in quantifying the neuro-muscular de-compensation caused by this injury. It has been revealed that a de-compensation in this ratio is correlated to a greater rate of muscular injuries in the lower body.

**Methodology**

The study design was experimental type with comparison of pre and post test values. The study done at Chennai with 30 samples convenient sampling. The study duration was 6 weeks with 18 sessions. The inclusion criteria consists of male subjects aged 18 to 24 years who will be athletes and those who were not under any specific plyometric training and liner periodization training program in the past 6 months. The excluded part had acute inflammation of lower limb and spine, recent fracture of lower limb and spine, who underwent any recent surgery to lower limb and spine. Hypermobility of lower extremities and muscle strain and sprain also excluded. The outcome measure are Quadriceps and Hamstring Muscle Strength of Maximum Voluntary Isometric Contraction (MVIC) using Push Pull Dynamometer.

**Procedure**

A total of 30 collegiate athletes were selected and divided into two groups and explained about the study. GROUP A: consist of 15 subjects who were trained with plyometric training program. GROUP B: consist of 15 subjects who were trained with linear periodization training program. The subjects were instructed in case any subject discontinued the exercise program or if he develops any pain or injury during exercise program they would be excluded from the study. A total of 3 session per week for 6 weeks (18 sessions). The outcome measure was muscle strength of quadriceps and hamstring muscles which was measured using push pull dynamometer. The pre test was measured before initiation of treatment session. The post test was measured end of the last session.

**Results**

On comparing the mean values of Group A & Group B on Muscle Strength Measurement in terms of Maximum Voluntary Isometric Contraction (MVIC) using Push Pull Dynamometer, both the groups shows significant increase in the post test Mean values but (Group A - Plyometric Training) Quadriceps 33.18 ± .943 pounds & Hamstrings 25.80 ± .830 pounds which has the higher mean value is more effective than (Group B - Linear Periodization) Quadriceps 29.90 ± 1.33 pounds & Hamstrings 22.51 ± .758 pounds at $P \leq 0.05$ Hence null hypothesis is rejected. On comparing Pre test and Post test within Group A & Group B on Maximum Voluntary Isometric Contraction (MVIC) of Quadriceps and Hamstrings muscle strength shows highly significant difference in mean values at $P \leq 0.001$

**Discussion**

The purpose of the study was to compare the effect of plyometric training and linear periodization on lower limb strength in collegiate athlete. 30 Subjects were selected. 30 Subjects were grouped in group A (15) and group B (15) Group A received plyometric training for lower limb and Group B received linear periodization for lower limb. Robert U. Newton (2009) results of this study support numerous previous studies that have concluded that plyometric training is an effective training method for the improvement of

Strength performers. Thus, the reported strength gains greater than >20 kg resulting from plyometric training could be of practical relevance for trained athletes in sports aiming at achieving optimum strength performance. Volume and frequency are very important parameters to be taken into account for an optimum plyometric training program design. Our analysis suggests that training for less than 10 weeks (i.e., between 6 and 10) with 3 sessions per week is more beneficial than similar programs of longer duration. Similarly, treatment with more than 15 sessions increases strength performance, whereas performance of more than 40 repetitions per session seemed to be the most beneficial volume. Riadh khlifa (2014) main finding of this study was the improvement of either vertical and horizontal jump performance in basketball players as a consequence of a multipurpose plyometric Training intervention (i.e., vertical and horizontal jump Exercises. This loaded plyometric training showed to provide a further advantage Over the standard condition. This confirmed the hypothesis giving evidence that loads added to dynamic exercise may provide training besides acute benefits over explosive-power performance. Specifically, the magnitude of the improvements experienced by the plyometric training was within the range of those reported in the international scientific literature in the athletic population. Philo U. Saunders (2013) performed study on "Effects of knee injury primary prevention programs on anterior cruciate ligament injury rates in female athletes in different sports: A systematic review". They concluded that three training programs in soccer and one in hand-Ball led to reduced ACL injury incidence. In basketball no effective training intervention is found. On season training is more effective than pre-season in ACL injury prevention. A combination of strength training, plyometrics, Balance training, technique monitoring with feedback, produced the most favorable results. On comparing the mean values of Group A & Group B on Muscle Strength Measurement in terms of Maximum Voluntary Isometric Contraction (MVIC) using Push Pull Dynamometer, both the groups shows significant increase in the post test Mean values but (Group A - Plyometric Training) Quadriceps 33.18 ± .943 pounds & Hamstrings 25.80 ± .830 pounds which has the higher mean value is more effective than (Group B - Linear Periodization) Quadriceps 29.90 ± 1.33 pounds & Hamstrings 22.51 ± .758 pounds at $P \leq 0.05$.

## Conclusion

The study concluded that plyometric training was found to be more effective and statistically significant in improve the hamstring and quadriceps muscle strength than linear periodization in collegiate athletes. There is a superiority in plyometric training exercises for lower limb muscle strength when compared with linear periodization exercises in collegiate athletes.

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## Conflict of interest

Nil

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