



EFFECT OF WEIGHT TRAINING FOR THIGH MUSCLES USING CLOSED KINETIC CHAIN EXERCISES ON PERFORMANCE ENHANCEMENT IN YOUNG FEMALE ATHLETES: A PILOT STUDY.

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ABSTRACT

BACKGROUND AND PURPOSE:

Weight training is commonly used in sports for prevention of injuries and in rehabilitation. The proportion of knee injury in weight lifting is 9%. During weight training, female demonstrated a high risk of accidental injuries and suffered more lower extremity injuries compared to male. Therefore, the purpose of the study is to evaluate effect of weight training for thigh muscles using closed kinetic chain exercises on performance enhancement in young female athletes.

METHOD:

Participants were screened for the inclusion criteria. 30 participants were recruited for the study. All the participants were assessed for outcome measures pre and post training. Training was started with warm up (15 minute) and end by cool down (15 minute). Training was given for 3 days per week for 4 weeks and final analysis was done. All the participants were assessed for vertical jump test and barbell squat test before and after the training. Data were analysed by using SPSS version 20 software.

RESULT:

53 participants completed the study. In the CKC group the mean score before training for vertical jump test and barbell squat test were 33.63704 cm and 30.64815 kg. After training, they were 36.14444 cm and 39.35185 kg respectively with p value 0.000.

CONCLUSION:

According to result, this study concluded that, CKCE was highly significant for increasing leg muscle strength and power than OKCE. However, participant who were given the OKCE showed less but significant improvement in comparison with CKCE.

KEY WORDS: OKCE, CKCE, Vertical jump test, Barbell squat test, weight training.

INTRODUCTION

The muscle of the thigh is subdivided into three compartments: anterior compartment, medial compartment and posterior compartment. Three major muscles comprise the anterior compartment of the thigh – the pectineus, Sartorius and quadriceps femoris^[1].

The quadriceps femoris is so called because consists of four parts: the rectus femoris, the vastus lateralis, the vastus medialis and the vastus intermedius^[2,3]. The quadriceps femoris connect to the patellar through the quadriceps tendon and receives innervations by the femoral nerve. The vastus muscles are responsible for knee extension as well as for stabilization of the patella. The rectus femoris is responsible for the flexion of hip and knee extension^[1]. Vastus lateralis is largest of the four muscles. Originate from the greater trochanter and lateral lip of linea aspera. It inserts at the lateral base and border of the patella forming the lateral patella reticulum and the lateral side of the quadriceps femoris tendon. Vastus medialis is originated from the inferior portion of the linea aspera. Inserts at the medial base and border of the patella forming the medial patella reticulum and the medial side of the quadriceps femoris tendon. Vastus intermedius is originates at the anterior and lateral surface of the femoral shaft. It inserts to the lateral border of the patella, forming the deep portion of the quadriceps tendon. Rectus femoris is comprised of two proximal heads: The straight head consist of the anterior inferior iliac spine of the ilium. The reflected head is include the ilium superior to the acetabulum. Inserts at the quadriceps femoris tendon^[1,2]. The iliopsoas dose not cross the knee joint and is responsible for flexion of the thigh and the ability to laterally rotate at the hip^[1].

CLOSED KINETIC CHAIN EXERCISE:

Closed kinetic chain (CKC) exercise can be described as “a condition or environment in which the distal segment meets considerable external resistance that restrains free motion”. Closed kinetic chain exercise is movement where the distal part is fixed, as when the sole of the foot make contact with the ground or any exercise equipment^[4]. CKC exercises are considered multijoint movement performed in a weight bearing or simulated weight bearing position with a fixed distal extremity^[5,6].

PREVALENCE:

During weight training, female demonstrated a high risk of accidental injuries and suffered more lower extremity injuries compared to male^[7]. Most training injuries occurred to the lower (55%) and upper (20%) limb and that the main diagnostic groups were muscle/ tendon (45%) and joint (43%) injuries^[8].

WEIGHT TRAINING:

Weight training is a type of strength training that uses weight or resistance. Weight training provides a stress to the muscle that causes them to adapt and get stronger^[9]. Weight training can be performed with free weights, such as barbells and dumbbells, or by using weight machines^[10].

VERTICAL JUMP TEST:

The vertical jump test is a test of lower body power. By this test directly measure the vertical jump height jumped. The vertical jump test is defined as standing on a platform, quickly performing a countermovement and jumping for maximal height and marked on the wall. Vertical jump height was define as the highest value among four trials^[11,12,13,14]. This test is highly reliable and valid^[15]. Reliability of vertical jump test is 0.97^[16].

BARBELL SQUAT TEST:

Barbell squat test is a test of lower body strength and core strength^[17]. A barbell squat is a free weight closed kinetic chain exercise involving muscles working across multiple joint. Participants completed three consecutive trials of lowering the maximum weight possible until the thighs were parallel to the floor and then raised the body to an erect position with an Olympic barbell on the shoulder^[18]. Reliability of barbell squat test is 0.93^[19].

METHODOLOGY

A. SOURCE OF DATA:

- Athletes of parul University, Limda, Ta – Waghodia, dist. Vadodara

B. METHOD OF COLLECTION OF DATA:

- **Study type:** Pilot study
- **Sample size:** 30 Subjects
- **Intervention duration:** 3 days/week for 4 weeks
- **Study duration:** 6 months

C. INCLUSION CRITERIA:

- Young female athletes
- Age group between 18 – 25 years
- Participants who can understand English, Hindi or Gujarati languages.

D. EXCLUSION CRITERIA:

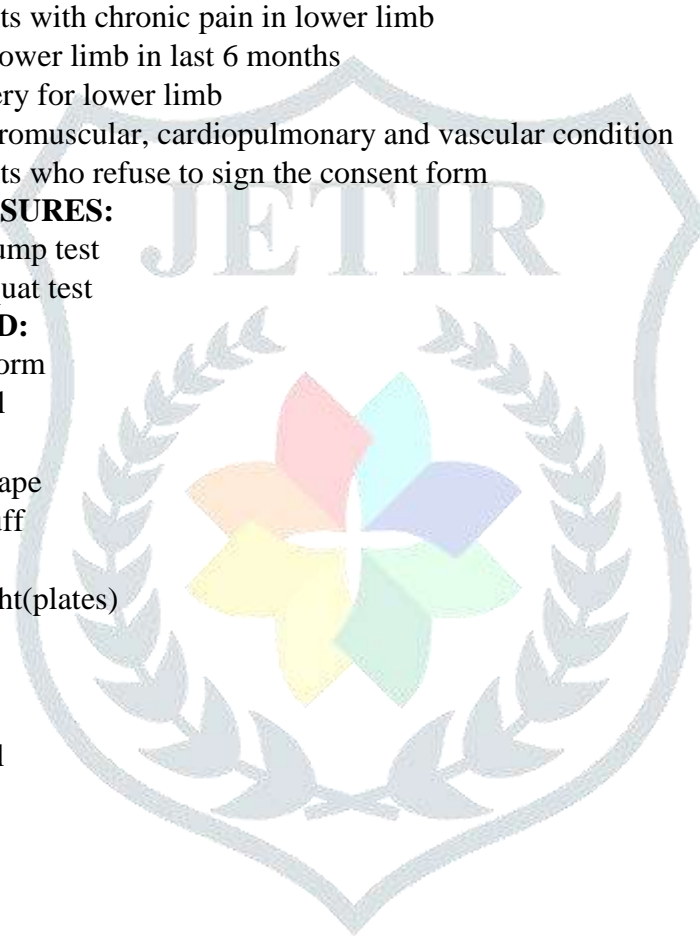
- Participants with chronic pain in lower limb
- Injury to lower limb in last 6 months
- Any surgery for lower limb
- Other neuromuscular, cardiopulmonary and vascular condition
- Participants who refuse to sign the consent form

E. OUTCOME MEASURES:

- Vertical jump test
- Barbell squat test

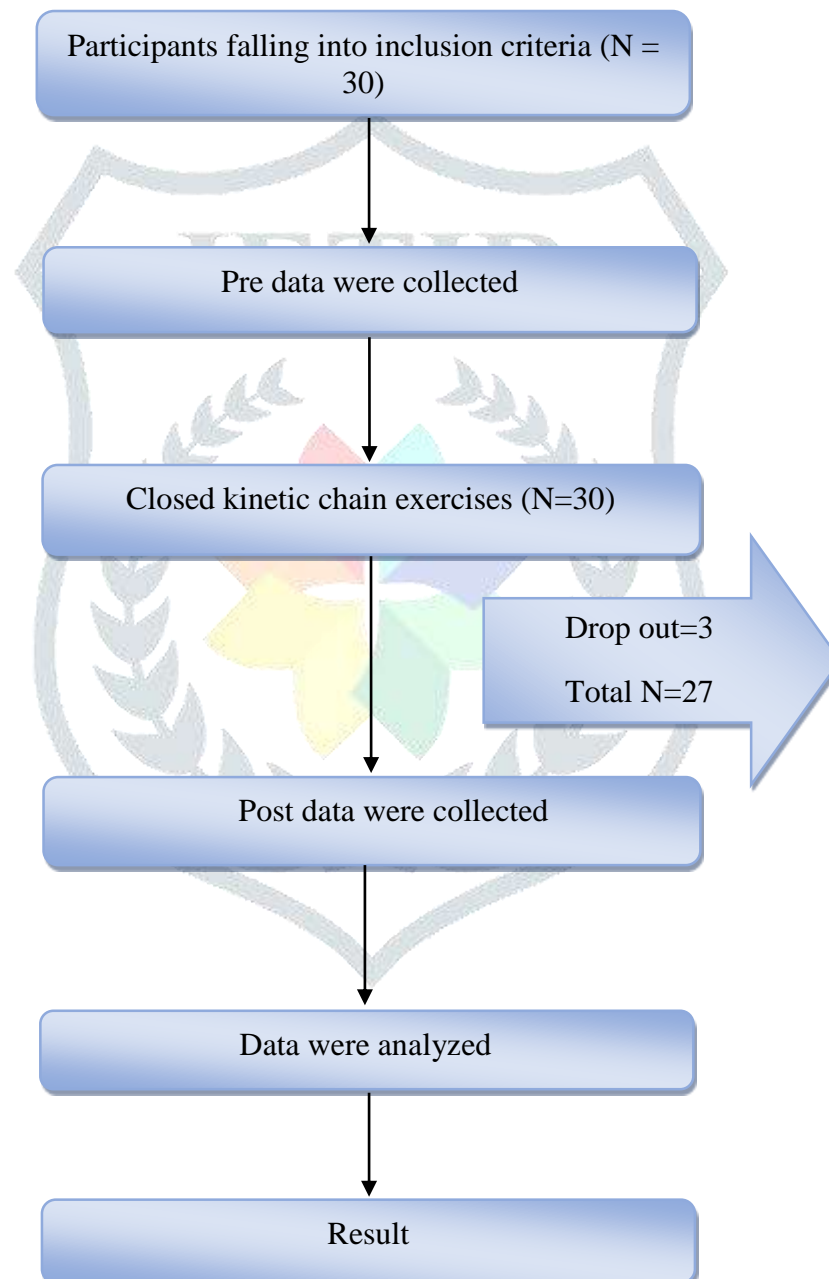
F. MATERIAL USED:

- Consent form
- Pen/pencil
- Chalk
- Measure tape
- Weight cuff
- Dumbbell
- Free weight(plates)
- Barbell
- Pillow
- Stairs
- Towel roll



PROCEDURE

Participants were selected from Parul University, at the age between 18 to 25 years old female athletes and screened for the inclusion and exclusion criteria and the ones falling into the inclusion criteria were then selected for study and explained in detail about the study and their role and importance in the study. 30 young female athletes were recruited for the study and a written consent form was taken from each participant and they were having complete freedom to refuse from participating in the study. Training was started with warm up (15 minute) and end by cool down (15 minute). The training session was of 1 hour which included 15 minutes of warm up, 30 minutes of training program and 15 minutes of cool down. A total training duration was 3 days per week for 4 week. The weight was progressively increase according participants ability to lift weight during training period. All the participants assessed for outcome measure before and after the training (before and at the end of 4 weeks). By the end of the 4th week 3 participants were drop out (the reason for drop out were all participant not come for regular training period).



VERTICAL JUMP TEST:

Each participant was made to stand against the wall(leaning on side to the wall), and reach up with the hand closest to the wall. Feet were kept flat on the ground, the point of the fingertips was marked. This is called the standing reach height. The participant then stand away from the wall, and jump's vertically as high as possible, and trying to reach the wall at the highest point of the jump. The difference in distance between the standing reach height and the jump height was measured as outcome score(figure 1).

BARBELL SQUAT TEST:

The participant was ask to stand under the bar, with feet shoulder – width apart. The knees should be in proper line with the toes. Take the weight on the shoulders, and then bend at the knees and hips to lower the body. The head and neck should be in a neutral position with eyes facing forward (avoid rounding of the spine). Lower the body until the knees are at a right angle, then push back up to a standing position(figure 2).



Figure 1
Vertical jump test



Figure 2
Barbell squat test

DETAILS OF THE TRAINING PROGRAM ARE AS FOLLOWS:

- 1 **Quadriceps setting:** The participants were instructed to sit on the chair with her back supported, knee extended and heel placed on the floor. The participants then pressed her heel against the floor and thigh against the seat of the chair (figure 3). Contraction was maintained for a count of 10 after then the participants relaxed. The exercise was repeated for 10 times.
- 2 **Wall slide:** In a standing position, the participants positioned her back up against the wall with hips and knees flexed to about 60° as she was preparing to sit on a chair (figure 4). The positioned was held for 10 seconds, after which the participants returned to the starting position and relax for 5 seconds. 10 repetitions of wall slides were carried out per exercise session. From second week, participants commenced wall slides with weight by holding dumbbells in both hands.
- 3 **Step up and step down:** The participants performed forward, backward and lateral step-ups and step-downs using a 5cm – high study wooden box. The participants were instructed to keep the trunk upright and she ensured that her heel was the last to leave the floor and the last to return in order to emphasize the activities of the quadriceps muscle (figure 5). The participants performed 10 repetitions of each components of the exercise. From second week, weight was strapped to ankle region for step-ups and steps down.
- 4 **Lunges:** The participants were in standing position. Placed one foot forward and bend the knee to the 90 degree angle (figure 6). The positioned was held for 10 seconds, after which the participants returned to the starting position and relaxed for 5 second. Then another foot placed forward and do same. The participants performed 10 repetition of each leg. From second week, participants commenced lunges with weight by holding dumbbells in both hands.

Table 1

Closed kinetic chain exercises	Repetitions
Quadriceps setting	10×3
Wall slide	10×3
Step up and step down	10×3
Lunges	10×3



Figure 3
Quadriceps setting



Figure 4
Wall slide



Figure 5
Step up and down



Figure 6
Lunges

DATA ANALYSIS

In the present study total 30 participants were recruited between the age group 18 to 25 years old female. Out of 30 participants 27 were analyzed for intragroup comparison on outcome measures.

STATISTICAL ANALYSIS:

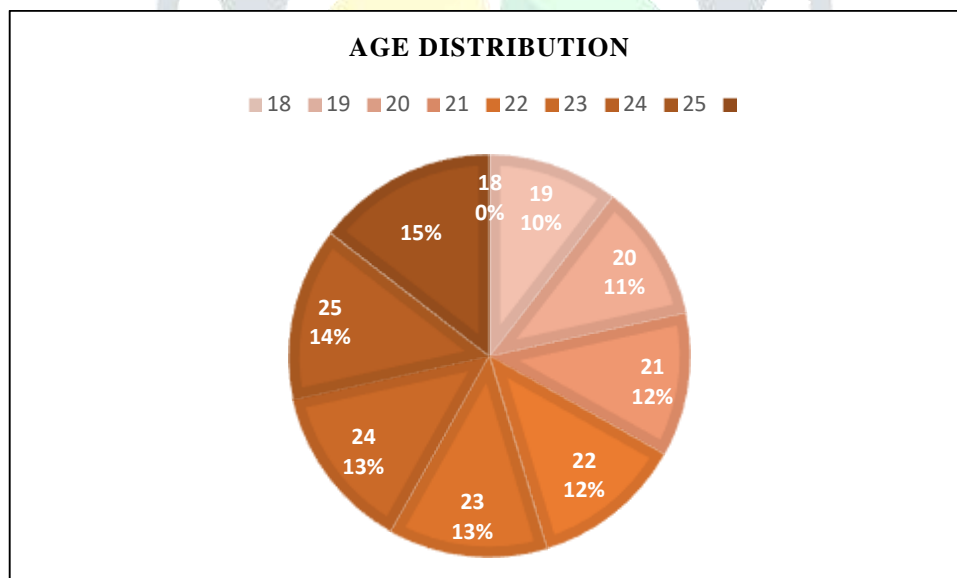
Descriptive statistical analysis was accomplished in the present study. Outcome measurement was measured using Vertical jump test and Barbell squat test. Confidence interval for this study 0.95 taken. 'p' value for the analyzed data was <0.05. Non parametric test was done and there we found data was follow normality. So, paired t test was used as a parametric test for intragroup comparison. The statistical software namely SPSS 20 was used for the analysis of data, Microsoft word and MS Excel 2019 was used to generate graphs, table.

RESULT

Table:2 age distribution

Age	CKC group
18	0
19	6
20	6
21	5
22	6
23	3
24	0
25	1

Graph:1 age distribution



INTRAGROUP ANALYSIS

Table:3 pre-post comparison of vertical jump test

CKC	MEAN	±SD	T-VALUE	DF	P-VALUE
PRE	33.6370	3.73189	16.714	26	0.000
POST	36.1444	4.02304			

Graph:2 pre-post comparison of vertical jump test value

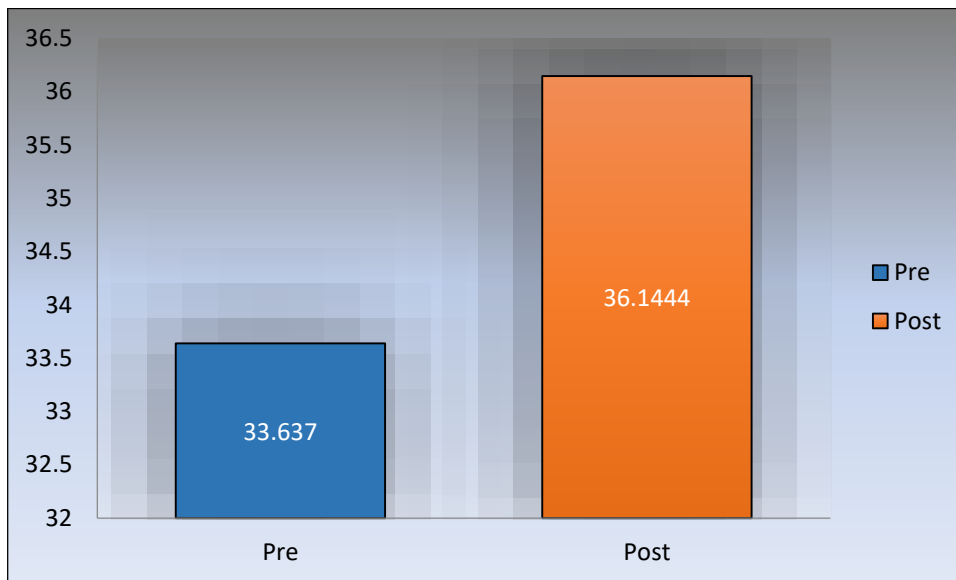
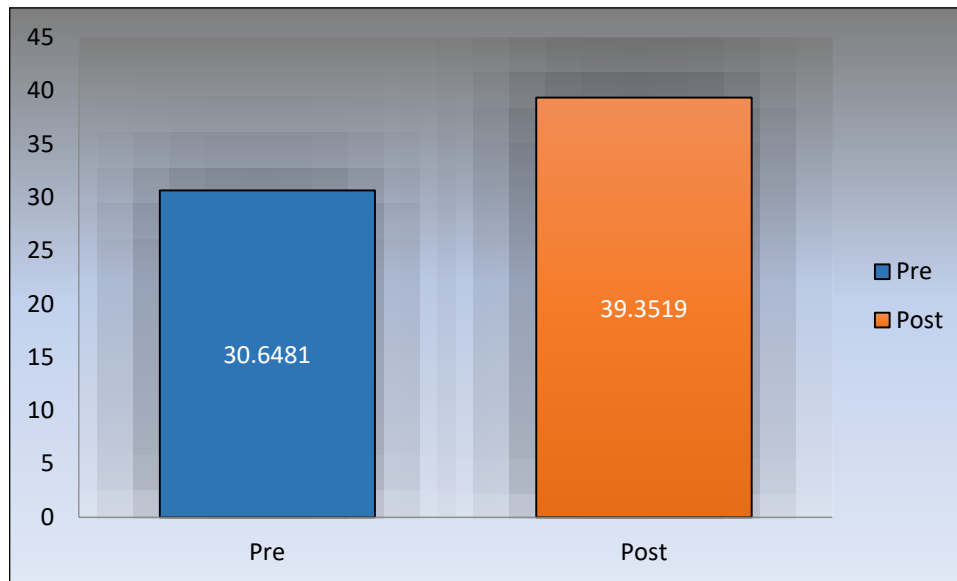


Table:4 pre-post comparison of barbell squat test

CKC	MEAN	±SD	T-VALUE	DF	P-VALUE
PRE	30.6481	3.43851	28.146	26	0.000
POST	39.3519	4.07812			

Graph:3 pre-post comparison of barbell squat test

DISCUSSION

The present study is an experimental study. The purpose of this study was to evaluate the effect of weight training for thigh muscles using closed kinetic chain exercises for performance enhancement in young female athletes. In this study, the muscle power was assessed by Vertical jump test and muscle strength was assessed by Barbell squat test in Parul University.

The results revealed post intervention were made by using the statistical analysis test that is Paired 't' test in Microsoft Excel software and SPSS version 20.

Lorenz D, Reiman M^[20] explain about CKC exercises contain more eccentric muscle work, and develops more muscle tension in the muscle and thereby obtains a greater training effect. During voluntary contraction of a muscle, speed of contraction and ability to exert tension are inversely related. During eccentric exercises (negative work), the oxygen consumption rarely rises to more than twice the resting value. Previous studies have shown that when a muscle is eccentrically lengthened, the energy requirement drop substantially in comparison to concentric contractions because ATP break down and heat production both are allowed.

Bigland – Ritchie et al^[21] found less muscle activity required to maintain the same force during eccentric exercises, fewer muscle fibers were required to exert a given force and there was a substantial reduction in oxygen uptake when fibers were eccentrically lengthened.

According to Manske RC, Davies GJ, Heiderscheid BC, Schulte R, Neitzel J^[22] differentiation must be made between relevance for activities of daily living, impact of shear and compression force and sensorimotor aspect of motor control.

According to Mayer F, Schlumberger A, Van Cingel R, Henrotin Y, Laube W, Schmidtbleicher D^[23] OKC and CKC exercises are involved in nearly all movements in sports and activities of daily living. In various forms of exercise such as walking and running, shooting or throwing movements, in which axial and/or rotational, external resistance is applied with fixed and/or free distal segment. In addition, Irrgang JJ, Neri R^[24] basic difference of OKC and CKC exercises is difficult. From a biomechanical point of view, shear and compression forces on a joint in nearly all movements.

Discussing about Muscle Power for group B measured with the help of Vertical jump test is shown in table 3 and graphically represented through graph 2, where the mean value post training increased to 36.1444 from 33.6370. Thus, showing significantly improvement of leg muscle power.

Discussing about Muscle Strength for group B measured with the help of Barbell squat test is shown in table 4 and graphically represented through graph 3, where the mean value post training increased to 39.3519 from 30.6481. Thus, showing highly significantly improvement of leg muscle strength

So now considering the hypothesis part, here as both the groups showed significant improvement, the alternative hypothesis made gets accepted each and null hypothesis made here are rejected post training groups have showed significant results by increasing in leg muscle power & improvement in muscle strength.

The mean and SD value of CKC group showed value post training was of 2.5074 ± 0.77951 for Vertical jump test, and for Barbell squat test the value it was upturned 2.9808 ± 1.00480 .

Hence, giving the Closed kinetic chain exercise is beneficial in improving the leg muscle power and leg muscle strength as the results were significant.

CONCLUSION

The present study was aimed to check the effect of weight training for thigh muscles using closed kinetic chain exercises. Based on analysis and result it was concluded that, Closed kinetic chain exercise was highly significant for increasing leg muscle strength and leg muscle power.

LIMITATIONS OF THE STUDY

- The sample size of study was small.
- The training period of the study was short.
- There was no long term follow up taken after the training to assess the beneficial effect of both groups.
- The participants in the study were taken from a single geographical area.

FURTHER RECOMMENDATIONS

- A further study can be conduct on comparison between male – female performance.
- A further study can be conduct for muscle activation.
- A multi centric study can be conducted by including participants from different geographical locations.
- A long duration study can be recommended along with follow-up sessions after a month of cessation of post training to check out the long-lasting benefits of both groups.
- This same study can also conduct on ACL reconstructive patients.

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