



## **Comparison between the Effects of Isotonic Concentric vs Eccentric Quadriceps Theraband Training on Vertical and Forward Jump in Healthy Young Adults: An Experimental Study**

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### **ABSTRACT**

*This study focus to contrast between the outcomes of isotonic concentric vs eccentric quadriceps theraband training on vertical and forward jump in healthy young adults. A total number of 17 subjects (6 males, 11 females) were included for the study. Divisions of total 17 subjects were done into 2 groups. First group comprised of 9 subjects and 8 subjects in the second group. In group 1 (concentric exercise) and in group 2 (eccentric strength training) were performed. 2 tests were used for measurements i.e., vertical jump test, and horizontal jump test. Assessment of the vertical jump and forward jump prior to the 6-week exercise training and after the training was done. The statistical analysis was done by using SPSS software version 24. The differentiation of concentric training and eccentric training groups (Between group analysis) on vertical jump and forward in young adults was done by using independent t- test and the significant value was set as  $p=0.05$ . This study concluded that the resistance training with Quadriceps the raband training is an effective way of improving vertical & forward jump in healthy young adults.*

**Keywords:** Resistance training, Quadriceps training, Vertical Jump, Forward Jump, Young Adults

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### **INTRODUCTION**

The quadriceps is one of the most important muscle and has the most volume in the human body. it constitutes of 4 muscles, vastus medialis, vastus lateralis, vastus intermedius muscles and rectus femoris. They are one among the strongest muscles in the human body and give the thigh its heft. The quadriceps help in knee extension. The rectus femoris helps in the flexion the hip. The vastus medialis helps in adduction of thigh and also extension and external rotation the thigh and stabilizes the patella.

1. The quadriceps are primarily involved in activities like dodging, kicking, hopping, cycling and running and sports like diving that requires jumps.
2. They help to get up from a chair, climb stairs walk, and squat in day to day life.
3. They help in foot strike in the stance phase and help in swing phase of gait cycle.
4. Muscle weakness of lower limb including quadriceps and ankle dorsiflexors is the major cause for decreased strength and endurance in young adults and falls in elderly. This is because most tasks are carried out at submaximal levels, rarely taking advantage of the advantages that more strength might provide. (Singh,Duda, Heller, Taylor &Arampatzis, 2010).

Greater quadriceps strength is related to fast walking speed which leads to higher knee adduction moment. (Kumar et.al, 2013. Quadriceps is the main focus as it is the major dynamic contributor helping in gain, posture and balance. (Rowe, Wright, Nyland, Caborn, & Kling 1999).

Quadriceps training is extensively used in patients (ACL, PCL, MCL, LCL) (Williams, Chmielewski, Rudolf, Buchanan & Mackler 2001). rehabilitation, chondromalacia patellae, osteoarthritis, etc. other conditions arising in young population like sacroiliac joint dysfunction (Lowry, Cleland & Dyke ,2008), Ilio tibial band syndrome, etc. further puts stress on quadriceps and fatigue levels in the muscle tend to increase.

Their deficits are a major part of mechanisms to ACL injuries (Williams et al .2001). Over the past years, resistance training has become an integral part of sports conditioning program. Strengthening exercises fall under this category which may be concentric or eccentric exercises involve high intensity exercises carried out for a very few numbers of repetitions.

As it comes to the sporting arena, it is an extremely important muscle but because of the immense amount of the stress it receives, that often results in trauma. The injury to the quadriceps muscle group, generally, is painful, disabling and debilitating. The absence from training and competition generally results from injuries like tears, strains and contusions of the muscle is common and can be easily noticed in sports such as hockey, rugby, football etc To determine suitable preventive strategies to decrease injuries, relationship between mechanism of injury and risk factors should be analyzed using a specific approach. Muscle strength and mainly muscle balance (quadriceps and hamstrings) are prime factors that maintain joint stability (Williams et al. 2001) with mechanisms such as co-contraction.

Eccentric and concentric exercises are used in both the patients and athletes for rehabilitation and training (Williams et al. 2001). A remarkable difference between the concentric and eccentric training modes is that the hypertrophy that is observed is at the specific areas of the muscle. Distal growth is associated in the eccentric mode of training and added noticeable mid belly hypertrophy is observed after concentric mode of training (Franchi, Reeves & Narici 2017).

Moreover, the similar entire muscle development is often detected in both types resistance training, the difference lies between the mechanisms of the structural transformation by which hypertrophy responses are attained in the two modes of strength training.

Major muscle groups in the lower limbs, including the hamstrings (37 percent), adductors (23 percent), quadriceps (19 percent), and calf muscles, were the site of 92% of all muscle injuries (13 percent ). Re-injuries made up 16% of the muscular injuries. (Ekstrand,2011).

Resistance exercise with the Thera-band as the modality is economical and hassle free, and has safety advantages. It is generally used for post-operative and post traumatic rehabilitation purposes because training can be selected subject to subject by controlling the loading intensity within the comfort zone of the patient and without posing risks (Yu, An, & Kang, 2013).

Good vertical jump and forward jump score is key indicator for athletes in many sports and is widely used in testing protocols for power.

Since 1980 and with resounding research and outcomes, the use of the Thera-band as an elastic resistance training (ERT) modality has become a common treatment intervention. Improved functional ability, enhanced strength and endurance with higher muscular activation, and reduced injury risks are some of its advantages (Lopez et al.2019). These jump training can involve both horizontal approach movements (SPJ, spike jump) and movements without an approach (Jousts, blocking, jump setting,etc) The objective of the study is to find the effectiveness of the elastic resistance training on quadriceps.

## **MATERIAL AND METHODS**

**Sample:** No. Of Subjects: 17 (young adults aged 18-25 years)

**Study Design:** Experimental study (Pretest post- test study design.)

### **Selection Criteria**

#### **1. Inclusion Criteria –**

- Young adults
- 18- 25 years
- Healthy
- Voluntary engagement in the study
- Both males and females

#### **2. Exclusion Criteria**

- Recent knee surgeries (Total Knee Replacement, ACL, PCL, MCL, LCL repair, etc.)
- Recent trauma at knee (Falls, direct trauma, etc.)
- Neurological deficits (PPRP, Sciatica, spasticity, other sensory or motor loss)
- Deformities at knee (varus, valgus, recurvatum injuries).
- Obese

**Sampling method:** Convenience sampling

### **Outcome Measures.**

- Vertical jump measurement
- Forward jump measurement

### **Instrumentation**

- Measuring tape

- Weighing scale
- Goniometer
- Data collection form
- Theraband blue
- Couch
- Chalk

### Protocol

.Subjects fulfilling the inclusion and exclusion criteria were included in the study



Informed consent was taken and signed by the subjects



Demographic details and baseline assessment were done



Assessment of the vertical jump and forward jump prior to the 6-week exercise training and after the training was done



Data collection was done using the data collection form

### PROCEDURE

In this study, 17 participants were selected on the ground of the inclusion criteria and exclusion criteria. An informed consent was taken prior to the study. Demographic detail and assessment were obtained.

#### Physical measurements

- Physical measurements included the measurement and assessment of height, weight and BMI.
- Height was measured using tape measure. For weight measurement weighing machine was used.
- BMI- It a reliable way to relate the height and weight of an individual. Weight and height measurements were taken during the assessment of the subjects and Later, BMI was computed by dividing a person's weight (in kilograms) by their height (in square metres).

1.	Underweight	<18.5
2.	Normal	18.5-22.9
3.	Overweight	23.0-24.9
4.	Obese	>25

**Table -1.1 Classification according to BMI**

#### Forward jump assessment

The participant was asked to jump from a baseline as long as he \she could. The distance from the baseline to forward end of the shoe was calculated using a measuring tape.

#### Vertical jump assessment:

The subjects started with foot on the baseline with hands on their hips. They were then requested to hold a knee position at about 120 degree knee angle and on the count of 4 the participant had to jump as high as he/she could. The measurement of the highest point was checked on a wall mounted inch tape. The participants were splitted into concentric and eccentric training group and a 6 week, 3 days per week alternate training was given to each group. Vertical and forward jump were measured before and after training.

#### Exercise training

The maximum repeat was not measured and the resistance strength was determined using a scale from 0 to 10. On this scale, a rating of 5-6 ("somewhat severe") indicates moderate intensity and a rating of 7-8 ("difficult") indicates severe intensity. Each subject performed the following exercises that constituted the 10 minute warm up session. The stretch protocol incorporated of the following stretches, each held for 20 seconds (timed with a stopwatch to certify precision).

- Standing toe touch.
- Long sitting toe touch.
- Standing forward and rush with your right foot facing forward.
- Rush on the right
- Standing left side lunge
- Lunge standing in front with his left foot facing forward
- Standing right quadriceps stretch.
- Standing side bend to the right.
- Standing left quadriceps stretch
- Toes rise while standing with straight legs bent.
- Standing side bend to the left.

- Calf stretches
- 5-minute jogging

Both the eccentric and concentric group performed the following exercises:

Knee flexion and knee extension with the blue Theraband. There was a rest of 30 seconds after every exercise.

Position	Number of sets
Prone	10x3
Side lying	10x3
Sittings	10x3
Standing	10x3

**Table 1.2 Exercise Protocol**

The blue colored resistance band was used during the protocol of the study. The blue resistance band is very thick and the difficulty / exercise intensity level is intermediate / advanced. Both group performed the same exercised however, eccentric group experienced resistance in knee flexion and concentric group experienced resistance in knee extension. The Theraband was tied at the ankle. All measures were taken to avoid trick movements at trunk and hip joints. The implementation of an exercise was 7 minutes. In total it took 40 minutes for 1 session (10 min warm up + 30 min Theraband exercise).



**Fig 1.1 Weighing scale for weight measurement**

- Also to find the effect of concentric vs eccentric training on vertical jump and forward jump.
- To find the association of the training on vertical and forward jump in healthy young adults.



**Fig. 1.2 Subject performing Forward Jump**



**Fig. 1.3 Vertical Jump Test**



**Fig. 1.4 Subject performing warm up exercise- toe touching in long sitting**

## DATA ANALYSIS

The statistical analysis was done by using SPSS software version 24. The data entry was done on Microsoft excel 2013 and statistical analysis. The demographic profile of age was analyzed by using descriptive statistics and. The effects between the pretest and post-test values was done by repeated measure ANOVA in both groups. The comparison effect of concentric training and eccentric training groups (Between group analysis) on vertical jump and forward in young adults was done by using independent t- test and the significant value was set as  $p=0.05$ .

## RESULT

### Demographic Profile of the subjects

A total number of 17 subjects (6 males,11 females) were included for the study. Division of 17 subjects were done in 2 groups. 9 subjects in first group and 8 subjects in the second group were comprise. In group 1 (concentric exercise) and in group 2 (eccentric strength training) were performed. 2 tests were used for measurements i.e., vertical jump test, and horizontal jump test.

#### Group 1

Mean age was  $20.78 \pm 0.44$ , mean weight was  $58.511 \pm 4.89$ , mean height  $161.34 \pm 10.23$ , and mean BMI was  $22.27 \pm 4.11$

#### Group 2

Mean age was  $21.25 \pm 0.71$ , mean weight was  $54.88 \pm 8.74$ , mean height  $161.38 \pm 5.13$ , and mean BMI was  $21.05 \pm 3.12$ .

### Within Group 1 analysis using repeated measure ANOVA for group 1

Repeated measure ANOVA within the group (Group-1) was done to find the effect of concentric training on vertical jump and forward jump in healthy young adults. The mean values in pre- test for vertical jump and forward jump are  $31.98 \pm 10.36$  and  $152.32 \pm 37.85$  respectively. The mean values in post-test at 4 weeks for vertical jump and forward jump are  $32.59 \pm 9.95$  and  $155.55 \pm 37.83$  respectively. The mean values in post-test at 6 weeks for vertical and forward jump are  $33.80 \pm 10.48$  and  $157.82 \pm 36.06$  respectively The result of the present study showed statistically significant difference between pre to post intervention for vertical jump test ( $f=15.195, p=0.000$ ) and for forward jump ( $f=11.699, p=0.001$ ).

	Vertical Height		Forward Jump	
	Mean	Std. Deviation	Mean	Std. Deviation
Pre Variable1	31.98	10.36	152.32	37.85
4_post_vertical	32.59	9.95	155.55	37.83
6_post_vertical	33.8	10.48	157.82	36.06
F value	15.195		11.699	
p value	0		0.001	

**Table 1.3 Analysis of concentric group**

### Within Group analysis using repeated measure ANOVA for group 2

Repeated measure ANOVA within the group (Group-2) was done to find the effect of eccentric training on vertical jump and forward jump in healthy young adults. The mean values in pre- test for vertical jump and forward jump are  $28.49 \pm 9.73$  and  $144.22 \pm 37.32$  respectively. The mean values in post-test at 4

weeks for vertical jump and forward jump are  $29.21 \pm 9.31$  and  $146.61 \pm 36.28$  respectively. The mean values in post- test at 6 weeks for vertical and forward jump are  $30.35 \pm 8.52$  and  $148.53 \pm 36.30$  respectively The result of the present study showed statistically significant difference between pre to post intervention for vertical jump test ( $f=15.195, p=0.000$ ) and for forward jump ( $f=7.548, p=0.006$ ).

	Vertical Height		Forward Jump	
	Mean	Std. Deviation	Mean	Std. Deviation
Pre Variable1	28.49	9.73	144.22	37.32
4_post_vertical	29.21	9.31	146.61	36.28
6_post_vertical	30.35	8.52	148.53	36.3
F value	15.195		7.548	
p value	0		0.006	

**Table 1.4 : Analysis of eccentric group**

**Between Group Analysis using Independent t test**

	Group 1		Group 2		t value	p value
	Mean	Std. Deviation	Mean	Std. Deviation		
Pre Variable1	31.98	10.36	28.49	9.73	0.714	0.486
4_post_vertical	32.59	9.95	29.21	9.31	0.719	0.483
6_post_vertical	33.8	10.48	30.35	8.52	0.737	0.472
Pre Variable2	152.32	37.85	144.22	37.32	0.444	0.664
4_post_forward	155.55	37.83	146.61	36.28	0.495	0.628
6_post_forward	157.82	36.06	148.53	36.3	0.528	0.605

**Table 1.5 Between group analysis**

The mean value for post -test vertical jump in group 1 are  $33.80 \pm 10.48$  cms and in group 2  $30.35 \pm 8.52$  as mentioned in table. The mean value for post- test forward jump in group 1 is  $157.82 \pm 36.06$  cms and in group 2 is  $148.83 \pm 36.30$  cms respectively. The result showed that there is no remarkable statistically significant difference between Group1 and Group 2.

**DISCUSSION**

The goal of the study is to compare the effect of concentric quadriceps training and eccentric quadriceps training using resistance band on vertical jump and forward jump in young adults in which individuals between 18-25 years of age were involved. Two groups were made in which the individuals were assigned into group 1 and group 2. Group 1 received concentric training program and in Group 2 received eccentric strength training using elastic resistance band and in both the groups training were given for 6 weeks (thrice a week) alternatively.

The results in both groups showed statistically significant difference between pre test and posttest in both vertical and forward jump tests. This indicates that the resistance training with elastic band is an effective way of improving function. Anderson et al., (2008), found that training with combined resistance (elastic band and free weight exercise) was better than training with free weights only for developing strength in upper and lower body, and lower body power in resistance-trained individuals. The long-term effects of training are unknown, but combined resistance training can make a significant contribution to improving the performance of experienced athletes in the short term. The main finding of this study was that changing the resistance pattern using a heavy rubber band during 7 weeks of training resulted in significant strength and strength measurements over the 7 week training period compared to traditional resistance training. It's an improvement. Training resulted in a marked increase in the strength of concentricity and eccentricity in both concentric and eccentric subjects in favour of a study done by Blazevich 2007 which intended to find the architectural adaptations to the muscle in both training methods.

The result in this study revealed that the group 1 (concentric training) showed significant difference between pre to post intervention for vertical and forward jump test. Anderson 1991 found that Some studies have shown that strengthening the hip and / or knee extensors significantly improves vertical jump performance. Hintermeister (1998) indicated that peak (maximum) activity of the quadriceps all occurred soon after the onset of concentric muscle activation which is a strong evidence for the increase in the strength of the muscle an hence improved the muscle activity The quadricep muscles were very active during concentric conditions because the knee extended during the push-off phase, with the vastus medialis, vastus lateralis, and rectus femoris showing the peak intensity.The result of the group 2 (eccentric training) also lead to the result that significant difference between pre to post intervention for

vertical and forward jump test. Eccentric contraction is unique. Compared to concentric contractions, muscles produce more tension and have lower metabolic demands. Training muscle for these eccentric activities like jumping, running etc. decreases the risk of injuries. Bishop and Durrant [4] concluded that eccentric training of the ham-strings improves the ability of the muscle to perform better eccentric activity along with enhancing concentric muscular activity.

When we did a comparison between two groups i.e. concentric training and eccentric strength training, results showed that there was no statistically significant difference on vertical and forward jump as compared to eccentric strength training group. This suggests that both the training protocols can be implied for training. This is of a great use in the sports like diving, basketball, football in which both stride and height of a jump are important. Also, TheraBand training are extensively used in clinical settings for patients.

As stated by Duncan the results of this study are similar to Mannheimer's in which comparison of both modes of training i.e. eccentric and concentric exercise was done. The study showed that the force production of the elbow flexors (biceps brachii and brachioradialis) of the eccentric group improved slightly more than that of the concentric group. However, this difference was not remarkable. Johnson's study in which the knee flexors during eccentric and concentric exercise was studied by analyzing their force gains, is also similar to Mannheimer's. Johnson et al. Used more pronounced eccentric loading intensity and demonstrated that both the training modes i.e. concentric and eccentric training produced remarkable improvement in force generation but neither of the two modes of exercise turned out to be superior. Hence both the protocols should be employed to gain the best results.

#### **LIMITATIONS OF THE STUDY**

- Small sample size..
- Dearth of a control group in the study.
- The reasoning for the number of sets, repetitions, and holding times was not based on evidence but on general guidelines,
- Repetition maximum was not measured.
- Limited Duration of the exercise protocol.

#### **FUTURE SCOPE OF THE STUDY**

Future study will be needed to compare the effect of concentric strength training and eccentric training on vertical jump and forward jump on healthy young adults with large sample size and control group. The reasoning for exercise protocol has to be evidence based in future studies. We can also perform the study to check progression using Thera bands of increasing resistance.

#### **CLINICAL IMPLICATIONS**

Theraband exercises can prove highly beneficial for patients when incorporated in post-surgery rehabilitation protocol. It helps in strengthening of a variety of muscles and reverses the effects of disuse atrophy. It has an important role in the rehabilitation for sport persons before returning to the game.

#### **CONCLUSION**

17 subjects who completed the study were analyzed. There was significant difference present in both training groups in healthy young adults. However, there are no results about which mode is superior. Therefore, according to the study conducted strength can be enhanced by both the regimes. However, both concentric and eccentric modes should be incorporated for training in order to yield best results.

#### **CONFLICT OF INTEREST**

The authors declare that there are no conflicts of interest. The research received no specific grant from any funding agency in the public, community, or non-for profit sectors.

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