**Pakistan Journal of Rehabilitation**

OPEN ACCESS

**ORIGINAL ARTICLE** **Volume 12(Issue 1), 2023 | Page No.60-67**

# IMMEDIATE EFFECTS OF POST-ISOMETRIC RELAXATION AND STATIC STRETCHING ON QUADRICEPS MUSCLE DURING VERTICAL JUMP IN VOLLEY BALL AND BASKETBALL PLAYERS

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## ABSTRACT

**Background of the Study**: In today sports such as volleyball and basketball, Vertical Jump is considered as important component that enhance the performance of athlete. The aim of this study was to determine the effect of muscle energy technique on vertical jump performance in volleyball and basketball players.

**Methodology:** This Randomized Clinical Trial was conducted at Islamic International University Islamabad. Twenty-nine athletes of age 18 – 35 playing basketball and volley as part time/domestic level were included. Post isometric relaxation technique was applied on group A (n=15) and static stretching was applied on group B (n=14). Surface electromyography activity of quadriceps and abdominal muscle was recorded, stable time, airtime and vertical jump height were measured using two-axis force platform and vertical jump height was measured by motion sensor. Measurements were taken at baseline and immediately after applying interventions to both groups. Data entry and analysis were done by using software SPSS version 22.

**Results:** Of the 29 athletes, 15 were in the group A and 14 were in the group B. Immediate assessment of vertical jump height was not significantly improved by post-isometric relaxation relative to static stretching (p=0.594). Muscle recruitment, ground reaction and vertical jump height improved apparently after post isometric relaxation but not significantly.

**Conclusion:** It appears that post isometric relaxation and static stretching of quadriceps shows no significant difference in vertical jump height**.**

**Keywords:** *Athletes, Electromyography, Exercises, Force plate, Muscle energy technique, Post-Isometric Relaxation, Stretching, Volley ball, Basket ball*

## Introduction

In this contemporary era, it is important to perform meticulously for an athlete to score the most points for the team. Many sports, such as volleyball and basketball, require persistent leaping ability[1]. Vertical jump is also considered lower extremity plyometric exercise to increase athlete's performance and prevention of injury in athletes[2]. Before beginning any activity, athletes are

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**Citation:** Afzal MF, Arif A, Shahid A, Khan MH, Shafi H, Amjad I. IMMEDIATE EFFECTS OF POST-ISOMETRIC RELAXATION AND STATIC STRETCHING ON QUADRICEPS MUSCLE DURING VERTICAL JUMP IN VOLLEY BALL AND BASKETBALL PLAYERS. Pakistan Journal of Rehabilitation. 2023 Jan 4;12(1):60-67. https://doi.org/10.36283/pjr.zu.12.1/009

**Received: Wed, Dec 1, 2021** **Accepted: Tues, Nov 22, 2022** **Published: Tues, Jan 03, 2023**

recommended to warm up because preliminary warming muscles actively is thought to mitigate the risk of injury and improve outcomes[3]. Static stretching is used widely in the field during warm-up and training practices, because it is thought to be beneficial in the game by increasing the joint range of motion[4,5]. However, some researchers have concluded that there may be negative effects on the overall performance after application of static stretching that include reduction of overall power, speed and inducing a short-term strength in the muscles especially in high performance athletes[6,8]. Muscle energy technique is now used as manual technique to increase Range of Motion (ROM) and reduction of pain. It is a form of soft tissue treatment in which subject actively and precisely contracts muscles against the counterforce applied by the therapist, it increases the extensibility of muscle and joint motion[9,10]. Study conducted by Jonathan et al to determine the effects different duration of stretching on contractile properties of lower extremity muscles and concluded that moderate duration of static stretching play significant role in enhancing vertical jump performance[11]. There is also evidence by the study that acute effect of static stretching cause reduction in torque and myotendinous junction may prevent from injury prevention[12]. A study done by Hough et al compared the effects of dynamic stretching and static stretching on vertical jump performance on 11 healthy men who participated in competitive sports. This study concluded that, relative to dynamic stretching, vertical jump efficiency was significantly reduced after static stretching (4.19 ± 4.47%) and vertical jump performance after dynamic stretching was significantly improved.[13]. High intensity-load also prolonged the duration of post-activation potentiation and increased vertical jump performance[14].it is also concluded by the evidence that muscle energy technique is considered very effective in increasing range of motion, reduction of pain and enhancing flexibility of muscle.[15-17]. Young et al explored the effects of SS, proprioceptive neuromuscular facilitation and maximal voluntary contraction on explosive force production and jumping performance and concluded that significant decrement in the jump performance after SS as compared to other stretching techniques[3].The aim of the study was to determine the immediate effects of post-isometric relaxation (PIR) compared to static stretching (SS) on vertical jump height and EMG activity of quadriceps and abdominals after stretching as both structure involved during vertical jump. The impact of PIR and SS on ground reaction forces during vertical jumping was also assessed. It was believed that the vertical jump height would increase immediately after applying PIR compared to the SS.

## Methodology

### Study Design

A randomized controlled trial was performed among athletes in the Islamic International University Islamabad, for a period of One Year following approval by the Ethics Committee (RIPHAH/RCRS/Letter-0062). Athletes 18–35 years of age who played basketball and volleyball on a part-time or domestic basis were recruited in the study. Every athlete signed a written consent form before participating in the study. Athletes with a history of lower extremity strain/sprain in the last 6 months, neuro-musculoskeletal and cardiovascular pathology were excluded from the study. Thirty athletes were selected in the study that fulfills the inclusion criteria and 1 drop out during the study. Sample was selected by non-probability convenience sampling.

### Data Collection Tools

Athletes performed squat vertical jump on Two-axis force platform PS-2142 by PASCO. It allows measurement of vertical, horizontal and parallel forces applied directly on the platform. In normal

circumstances, forceplates have capacity to bear 4400N in normal direction and 1100N force when lie parallel to the surface. The size of forceplate was 35cm x 35cm in horizontal and vertical plane and total mass of forceplate was 6.4 $kg^3$. Forceplates were settled on the smooth and hard surface and connected with the computer via software of Pasco. Motion sensor (PS-2103) also attached on the forceplates that measure the position of feet and measure speed when jump or land on the forceplates. Surface electromyography (MP-36 BIOPAC) was used to check electrical activity of quadriceps and abdominal muscles. The device connected by electrode. Input and output devices and transducers. The tool is FDA approved and have high validity and reliability[18]. Two electrodes were mounted on quadriceps muscles with the distance of 4cm between them and 2 electrodes placed on the abdominal muscle with the same distance.

**Intervention**

Those athletes meeting the inclusion criteria were randomly assigned to group A (Muscle energy Technique) and group B (Static Stretching). Fifteen athletes who were included in the group A, each athlete was guided to avoid jerky movements and inhale during contraction phase and exhale during relaxation phase. The athlete assumed prone position. A physiotherapist performed post-isometric relaxation technique on the quadriceps muscles. First an end range of quadriceps muscles was assessed, and the athlete was requested to place 20% of their maximum voluntary contraction while the physiotherapist resisted this movement for 6-10 seconds. This process was repeated 4 times for each new range immediately without any rest interval. Post-reading assessment taken immediately after the intervention in lower extremities. Fourteen athletes were included in the group B. Static stretching was applied on athletes in prone position and Physiotherapist stands on the side of the tables and stretch applied for 30 seconds of duration. It included 3 stretches of 30 seconds duration with 20 seconds rest intervals between each stretch. Post-reading assessments were taken immediately after the interventions.

**Statistical Analysis**

Data was entered and analyzed through SPSS version 22. Test of normality applied to check distribution of data. Demographics of the result presented in Mean and Standard Deviation. Pre and post-assessment analysis was done by Paired Sample T Test and group comparison was done by Independent Sample T test.

## Results

The demographics of the study shows that mean age and standard deviation of both groups was 20.87±1.13 and 20.78±1.80 respectively. The body mass index (BMI) of athletes was 21.41±1.90 and 22.83±3.06 in group A and group B respectively. The demographics of the subjects are shown in table 1.

| Variables | Group A (Mean ± Standard Deviation) | Group B (Mean ± Standard Deviation) |
|---|---|---|
| **Age (Years)** | 20.87±1.13 | 20.78±1.80 |
| **Height (Inches)** | 67.87±2.26 | 67.43±3 |
| **Weight (Kg)** | 63.07±7.54 | 68.50±11.61 |
| **BMI ($Kg/m^2$)** | 21.41±1.90 | 22.83±3.06 |

***Table 1 Shows Demographics of Experimental and Control Group. (N= Number of Subjects)***

| | | Group A (n=15) | Group B (n=14) | P value |
|---|---|---|---|---|
| EMG Quadriceps (Jumping) | Baseline Assessment | 0.447±0.154 | 0.396±0.171 | 0.405 |
| | Post Assessment | 0.424±0.110 | 0.495±0.204 | 0.247 |
| EMG Abdominals (Jumping) | Baseline Assessment | 0.079±0.177 | 0.056±0.065 | 0.648 |
| | Post Assessment | 0.073±0.103 | 0.051±0.061 | 0.507 |
| Force plates Airtime | Baseline Assessment | 2.22±0.430 | 2.503±0.820 | 0.248 |
| | Post Assessment | 2.14±0.518 | 2.39±0.470 | 0.182 |
| Force plates Stability | Baseline Assessment | 2.99±0.500 | 3.23±0.912 | 0.379 |
| | Post Assessment | 2.88±0.578 | 3.089±0.519 | 0.327 |
| Vertical Jump Height | Baseline Assessment | 0.298 ±0.119 | 0.328±0.140 | 0.583 |
| | Post Assessment | 0.300±0.147 | 0.324±0.126 | 0.594 |

***Table 2 Shows Comparison of Group with Mean±SD and P Value***

Electrical activity of Quadriceps and Abdominal muscles was assessed through Electromyography and Airtime, Stability and vertical jump height were assessed through forceplates. The electrical activity of Quadriceps during jumping at baseline was 0.424±0.110 and 0.495±0.204 in group A and B respectively which show no statistically significant difference in both intervention (P value=0.24). The electrical activity of abdominal muscles recorded by the electromyography shows baseline mean±SD is 0.42±0.11 and 0.49±0.20 in group A and group B respectively. Post-intervention assessment by electromyography shows mean±SD in group A and B was 0.07±0.10 and 0.05±0.06 during jumping phase that shows no significant difference in both intervention (value=0.51).

| | Groups | Baseline Assessment Mean±SD | Post-intervention Assessment Mean±SD | P value | Cohen's D |
|---|---|---|---|---|---|
| EMG Quadriceps (Jumping) | Group A (n=15) | 0.447±0.154 | 0.424±0.110 | 0.465 | 0.20 |
| | Group B (n=14) | 0.396±0.171 | 0.496±0.204 | 0.176 | 0.43 |
| EMG Abdominals (Jumping) | Group A (n=15) | 0.079±0.177 | 0.073±0.104 | 0.913 | 0.032 |
| | Group B (n=14) | 0.561±0.655 | 0.519±0.615 | 0.824 | 0.05 |
| Force plates Airtime | Group A (n=15) | 2.219±0.431 | 2.137±0.518 | 0.663 | 0.173 |
| | Group B (n=14) | 2.503±0.820 | 2.389±0.470 | 0.663 | 0.17 |
| Force plates Stability | Group A (n=15) | 2.99±0.500 | 2.88±0.58 | 0.571 | 0.20 |
| | Group B (n=14) | 3.232±0.913 | 3.089±0.549 | 0.582 | 0.19 |
| Vertical Jump Height | Group A (n=15) | 0.298±0.119 | 0.300± 0.147 | 0.909 | 0.258 |
| | Group B (n=14) | 0.328± 0.140 | 0.324± 0.126 | 0.880 | 0.027 |

***Table 3 Shows within Group Comparison of Group A and Group B with Mean±SD and P Value***

The airtime was recorded by the forceplates when athlete remains in the air and their feet's contact back to the forceplates after vertical jump. The airtime of subjects after application of intervention was 2.14±0.51 and 2.39±0.47 in group A and group B respectively that shows no significant difference in both intervention (p value=0.182). The mean±SD of vertical jump height in group A and group B was 0.30±0.15 and 0.32±0.12 respectively. There is no statistically significant difference between the intervention (P value= 0.59). Paired sample-test was used to measure pre-

intervention and post-intervention assessment of Group A and Group B. The vertical jump height mean±SD of group A was 0.29±0.11 at baseline and 0.30± 0.14 immediately after the application of intervention and there is no statistically significance (P value=0.909). Cohen's D shows mild effect size (Cohen's D=0.258). The vertical jump height mean±SD of group B was 0.32± 0.140at baseline and 0.32± 0.12 immediately after the application of intervention and there is no statistically significance (P value=0.88)

## Discussion

From the origin of sports, coaches with their team members focus on the athlete's performance and prevent them from injury. Vertical jump that includes eccentric muscle activity of quadriceps used in almost all sports with major or minor role and vertical jump is one of the important components in athlete's performance. The purpose of this study was to determine, immediate effects of the Post Isometric Relaxation (PIR) as compared to the Static Stretch on vertical jump height. Electrical activity of quadriceps and abdominal muscles were measured during the jumping phase of vertical jump. Forceplates were used to assess the stability time of subjects when their feet's contact the forceplates, airtime and jumping height. The baseline mean±SD of vertical jump height in group A was 0.298±0.119. Post-isometric relaxation technique was given to the subjects with 20% activation of their muscles and hold of 10 seconds with 4 repetitions. The post-intervention assessment of group A shows mean±SD was 0.300± 0.147 with P value= 0.909 which shows that there is no significant effect of muscle energy technique but there is mild effect size of muscle energy technique apparently Cohen's D= 0.258. Lauren Noto Bell et al conducted a study in 2019 on competitive swimmers to determine the effect of post-isometric relaxation technique on ankle range of motion and concluded that range of motion of bilateral ankle joint increase but there is no immediate improvement in the performance of swimmers.[19]. The agility is considered as reaction time to the assigned task and vertical jump also required less reaction time to act on the given task. T Buress et all conducted a study on forty healthy active males to determine the effect of contract relax agonist contract stretch which resembles with the post-isometric relaxation technique, the study also concluded that intervention increase 237% hamstring flexibility immediately after the application of intervention but there is no significant effect on agility and speed[20]. A recent study conducted in 2020 to compare active isolated stretch with post-isometric relaxation in enhancing flexibility of hamstring muscles in young adults and concluded that there is no significant difference of both interventions[21].The baseline mean±SD of vertical jump height in group B was 0.328± 0.140. Static stretch of quadriceps was applied for the duration of 30 seconds with 20 seconds of rest interval and 2 repetitions of stretch were applied. The post-intervention assessment of group B shows mean±SD was 0.324± 0.126 with P value= 0.880 which shows that there is no significant effect of static stretching. A study conducted by Lucas P et al in 2018 to compare different types of stretches on sprint and vertical jump performance that concluded that passive or static stretch shows negative effect on vertical jump performance[22]. A pilot study conducted by Agnieszka et al in 2020 to see the influence of static stretch on vertical jump parameters of volley ball players and concluded that static stretching have negative effect on performance parameters immediately after application of static stretching[23,24]. A critical and systematic review was done in 2020 to see acute effect of warm up, exercise and recovery strategies on performance of soccer players that also concluded that accuracy of kicking, velocity

of ball improved by using dynamic stretching as warm-ups but static stretching reduce performance parameters in soccer players[25].

## Conclusion

It is concluded by the current study that muscle energy technique and stretching shows no significant difference on vertical jump whereas it seems that muscle recruitment, ground reaction forces were improved by post isometric relaxation in comparison to static stretching. Further study should be done by adding follow-up after 24 hours and large sample size

**AUTHORS' CONTRIBUTION:**
The following authors have made substantial contributions to the manuscript as under:
**Conception or Design:** *Dr. M. Faheem Afzal, Dr. Adeela Arif*
**Acquisition, Analysis or Interpretation of Data:** *Dr. Amna Shahidii , Dr. Manan Haider Khan*
**Manuscript Writing & Approval:** *Dr. Hina Shafi, Dr. Imran Amjad*

All authors acknowledge their accountability for all facets of the research, ensuring that any concerns regarding the accuracy or integrity of the work are duly investigated and resolved.

**ACKNOWLEDGEMENTS:** We thanks all the participants in this study.

**INFORMED CONSENT:** Written Informed Consent was taken from each patient.

**CONFLICT OF INTEREST:** The author (s) have no conflict of interest regarding any of the activity perform by PJR.

**FUNDING STATEMENTS:** None declared

**ETHICS STATEMENTS:** The study has been approved by the Ethics Committee (RIPHAH/RCRS/Letter-0062)

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