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Research

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# Effect of a 6 Week Plyometric Training Program on Agility, Vertical Jump Height and Peak Torque Ratio of Indian Taekwondo Players

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## ABSTRACT

**Purpose:** Taekwondo demands for quick change in direction while keeping balance, strength, speed and body control through high level of lower limb strength, agility to improve performance.
**Methodology:** 30 elite national level male Taekwondo players (mean age 22.0±1.6 years; mean Height, 174.4±4.4; mean mass 62.4±6.9 kg, training experience were 21±2.29 years, 5±1.70 years respectively) were divided into two groups, G1 (n=15) has undergone plyometric training for 6 weeks and G2 (n=15) control group. Before and before after 6 weeks all subjects underwent for Illinois agility test, vertical jump by kinematic measurement system t and isotonic muscles (Hamstrings - quadriceps) peak torque ratio by isokinetic dynamometer.
**Result:** After 6 week of plyometric training program agility, vertical jump height and peak torque ratio was improved significantly ($p$<0.05) in G1 group (plyometric training group). No significant changes found in G2 group (control group).
**Conclusion:** Improvement in agility, vertical jump and peak torque ratio of taekwondo players occur after 6 week of plyometric training which will reducing the risk of lower limb injuries.

**KEYWORDS:** Taekwondo; Plyometric Training; Agility Test; Vertical Jump; Peak Torque Ratio.

## INTRODUCTION

The word "Taekwondo" is derived from the Korean word "Tae" means "to kick"; "Kwon" implies "punching" and "Do" means "method." Thus taekwondo is the technique of self defence that involves the skilful application of techniques that include punching; jumping kicks, blocks, actions with hands and feet. Taekwondo is a form of martial art that has evolved by combining many different styles of martial arts that existed in Korea.

Plyometrics are training techniques used by athletes in all types of sports to increase strength and explosiveness.[1] Plyometrics consists of a rapid stretching of a muscle (eccentric action) immediately followed by a concentric or shortening action of the same muscle and connective tissue.[2] Researchers have shown that plyometric training, when used with a periodized strength-training program, can contribute to improvements in vertical jump performance, acceleration, leg strength, muscular power, increased joint awareness, and overall proprioception.[3]

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Agility is the ability to maintain or control body position while quickly changing direction during a series of movements.[4] Agility training is thought to be a re-enforcement of motor programming through neuromuscular conditioning and neural adaptation of muscle spindle, Golgi-tendon organs, and joint proprioceptors.[5-7] Performance is often dependent upon the athlete's jumping ability during offensive and defensive skills.[8]

Jump performances appears to be contingent on the quantity and efficiency in which force is produced at the hip, knee and ankle joints, explosive strength of the legs and hips should result in a higher vertical jump.

The most common sports in which one's vertical jump is measured are track and field, basketball, football and volley ball, taekwondo. Although plyometric training has been shown to increase performance variables, little scientific information is available to determine the effect of plyometric training on taekwondo players and if plyometric training actually enhances agility, vertical jump height and peak torque ratio in taekwondo players. Therefore, the purpose of this study was to determine the effect of a 6-week plyometric training program on agility, vertical jump height and peak torque ratio of Indian taekwondo players.

## METHODOLOGY

30 elite national level male Taekwondo players (Based on these findings, the Indian taekwondo athletes were shown significant improvement in agility, vertical jump height and peak torque ratio in dominant and non-dominant leg after 6 weeks of plyometric training. age, training experience were 21±2.29 years, 5±1.70 years respectively) gave their informed consent to serve as subjects in the study. The procedure, benefits, and potential risks of study were explained to the participants before signing the informed consent form and starting the test. The study was approved by the Institutional Ethics Committee of Faculty of Sports Medicine and Physiotherapy, Guru Nanak Dev University, Amritsar.

Inclusion criteria included that subjects agreed with the purpose of this study, subject with musculoskeletal problems such as lower limb fracture and sprain/strain, existing neurologic problems as well as respiratory or cardiovascular system problems were excluded.[9]

The subjects of the study were randomly divided into two groups: a control group (n 15), a plyometric exercises group (n 15). All subjects agreed not to change or increase their current exercise habits during the course of the study. The plyometric exercises group participated in a 6-week exercises program performing a variety of plyometric exercises designed for the lower extremity (Table 1), while the control group did not participate in any plyometric exercises. Participant were tested pre and post the 6 week training period. Before testing, participants performed a 5- minute warm-up protocol consisting of submaximal running and active stretching. Kinematic Measurement System (Fitness technology, Australia) , Isokinetic Dynamometer (60º/sec ) and Illinois test was used to measure the vertical jump height , peak torque ratio and agility. All dependent variables were entered into Statistical Package for Social Sciences (SPSS Inc., Chicago, Ill) 17 version.`

| Training Week | Training volume (foot contacts) | Plyometric Drill | Sets × Reps | Training Intensity |
|---|---|---|---|---|
| Week 1 (3 days per week; an alternate day) | 90 (2-3 min rest intervals) | Side to side ankle hops | 2×15 | Low |
| | | Standing jump and reach | 2×15 | Low |
| | | Front Cone Hops | 5×16 | Low |
| Week 2 (3 days per week; an alternate day) | 120 (2-3 min rest intervals) | Side to Side ankle hops | 2×15 | Low |
| | | Standing long Jump | 5×6 | Low |
| | | Lateral jump over barrier | 2×15 | Medium |
| | | Double leg hops | 5×6 | Medium |
| Week 3 (3 days per week; an alternate day) | 120 (2-3 min rest intervals) | Side to Side ankle hops | 2×12 | Low |
| | | Standing long jump | 4×6 | Low |
| | | Lateral jump over barrier | 2×12 | Medium |
| | | Double leg hops | 3×8 | Medium |
| | | Lateral cone hops | 2×12 | Medium |

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| | | | | |
|---|---|---|---|---|
| Week 4 (3 days per week; an alternate day) | 140 (2-3 min rest intervals) | Diagonal cone hops | 4×8 | Low |
| | | Standing long jump with lateral sprint | 4×8 | Medium |
| | | Lateral cone hops | 2×12 | Medium |
| | | Single leg bounding | 4×7 | High |
| | | Lateral jump single leg | 4×6 | High |
| Week 5 (3 days per week; an alternate day) | 140 (2-3 min rest intervals) | Diagonal cone hops | 2×7 | Low |
| | | Standing long jump with lateral sprint | 4×7 | Medium |
| | | Lateral cone hops | 4×7 | Medium |
| | | Cone hops with 180 degree turn | 4×7 | Medium |
| | | Single leg bounding | 4×7 | High |
| | | Lateral jump single leg | 2×7 | High |
| Week 6 (3 days per week; an alternate day) | 120 (2-3 min rest intervals) | Diagonal cone hops | 2×12 | Low |
| | | Hexagon drill | 2×12 | Low |
| | | Cone hops with change of direction sprint | 4×6 | Medium |
| | | Double leg hops | 3×8 | Medium |
| | | Lateral jump single leg | 4×6 | High |

**Table 1:** Plyometric 6-week training protocol.

## RESULT

In agility test experimental group shows six no improvement in agility after 6 week of plyometric training as well as in control group. (Table 2)

| Agility Test (sec) | Control Group | Experimental Group |
|---|---|---|
| Illinois Test | Pre-Test (sec) | Post –Test |
| Mean±SD | 17.13±0.41 | 17.13±0.42 |
| Mean±SD | 17.18±0.48 | 17.12±0.47 |

**Table 2:** Comparison of Agility (sec) pre and post training in Experimental and Control group.

In Vertical Jump test experimental group shows significant improvement in height after 6 week of plyometric training ($p<0.00$) whereas control group shows non significant result. (Table 3)

| Vertical Jump (m) | Control Group | Experimental Group |
|---|---|---|
| | Pre-Test | Post-Test |
| Mean±SD | 0.36 ±0.06 | 0.36±0.05 |
| Mean±SD | 0.37±0.05 | 0.40±0.06 |
| *p* value | 0.36 | <0.00 |
| T value | 0.359 | 3.67 |

**Table 3:** Comparison of Vertical Jump Height (m) pre and post training protocol in Experimental and Control group.

In isokinetic dynamometer (peak torque force) dominant and non- dominant Leg of Control Group shows non significant improvement but in plyometric group dominant leg and non dominant leg shows significant improvement ($p<0.01$), ($p<0.00$). (Table 4)

## DISCUSSION

Present study indicated that 6 weeks of plyometric training was able to increase peak torque ratio, agility, vertical jump height in Indian taekwondo players.

Peak torque force of dominant and non- dominant leg of plyometric group shows significant improvement ($p<0.01$), ($p<0.00$). Generation of absolute anaerobic power output depend directly on the amount of muscle mass, especially the thigh muscle cross-sectional area. Moreover, factor influencing maximal peak anaerobic power achieved by individual rely on present of the amount of type II muscle fibers.[9] Peak anaerobic power reflects short-term anaerobic performance and mean anaerobic power reflects intermediate-term performance.[10] Factors determining the anaerobic performance include morphological (muscle architecture and fiber type), physiological (efficiency of metabolic pathway), biochemical (substrate availability and accumulation of reaction products) and neuromotor (motor skill and motor unit recruitment) variables. Regular participation in a plyometric training program can improve measures of strength and power in adults.[11]

In present study, subjects who underwent in to plyometric training were no improvement in agility. Therefore, we were not found a positive relationship between plyometric training and improvements in agility test. In a previous study of plyometric training, the authors' reported that improvements were a result of enhanced motor unit recruitment patters.[7] Neural adaptation usually occurs when athletes respond or react as a result of improved coordination between the CNS signal and

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| ISOKINETIC DYNAMOMETER (PEAK TORQUE FORCE) | CONTROL GROUP | | | | PLYOMETRIC GROUP | | | |
|---|---|---|---|---|---|---|---|---|
| | DL | | NDL | | DL | | NDL | |
| | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| MEAN±SD | 0.55±0.11 | 0.56±0.09 | 0.56±0.11 | 0.55±0.11 | 0.71±0.12 | 0.73±0.13 | 0.68±0.09 | 0.70±0.09 |
| *p* value | <0.27 | | <0.21 | | <0.01 | | <0.00 | |
| T value | 0.61 | | 0.80 | | 2.41 | | 3.36 | |

**Table 4:** Comparison of Peak Torque force pre and post training protocol in Dominant and Non-Dominant leg in Experimental and Control group.

proprioceptive feedback.[6] However, in present we could not determine if neural adaptations occurred *via* synchronous firing of the motor neurons or better facilitation of neural impulses to the spinal cord which also supports the suggestions of Potteiger et al.[7] Therefore, more studies are needed to determine neural adaptations as a result of plyometric training and how it affects agility. In present study there was no improvement in agility performance.

In case of vertical jump there was significant improvement found in Plyometric training group in present study. Vertical jump performance, acceleration, leg strength muscle power, increased joint awareness and overall proprioception enhanced by plyometrics.[12]

This is in agreement with some studies which applied resistance training or soccer specific strength training programs and found increased ball speed during the kick so in taekwondo also there is need of increase power of lower leg and kick should be forceful therefore the present study will shows that the 6 weeks of plyometric training and resistance training both shows the significant improvement in agility vertical jump and peak torque force.

## CONCLUSION

Based on findings of this study, the Indian taekwondo athletes were shown significant improvement in agility, vertical jump height and peak torque ratio in dominant and non-dominant leg after 6 weeks of plyometric training which was very encouraging and demonstrate the benefits plyometric training can have on performance. Use of plyometrics can improve strength and explosiveness while working to become more agile. In addition, our results support that improvements in agility can occur in as little as 6 weeks of plyometric training which can be useful during the last preparatory phase before in-season competition for athletes. We recommended coaches and trainers to apply these training protocol to improve performance.

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The authors are thankful of their participants. The permission was taken from ethical committee of Guru Nanak Dev University, Amritsar, Punjab, India.

## STATEMENTS

### Contributorship

Jaspal Singh Sandhu provided the set-up for the study. Amrinder Singh planned the study and submitted the study. Avinash Kumar Boyat conducted the study.

### Funding

The set-up was organized by the Department of Sports Medicine and Physiotherapy, Guru Nanak Dev University Amritsar, Punjab (India) and there was no funding issues.

### Competing interests

There was no conflict of interests.

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