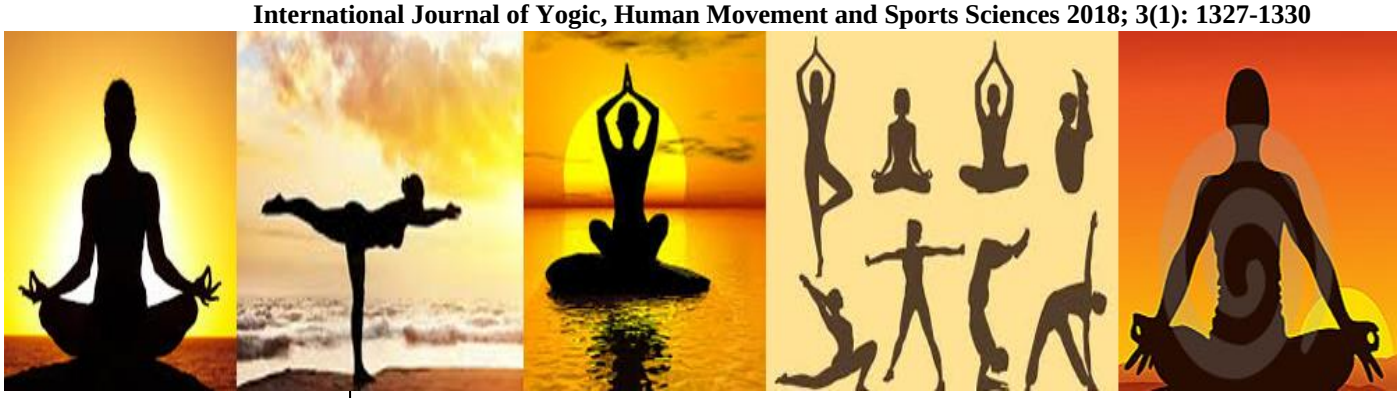
International Journal of Yogic, Human Movement and Sports Sciences 2018; 3(1): 1327-1330



ISSN: 2456-4419
Impact Factor: (RJIF): 5.18
Yoga 2018; 3(1): 1327-1330

www.theyogicjournal.com
Received: 17-01-2018
Accepted: 22-02-2018

Lalit S Sharma
Research Scholar, Sant Gadge Baba Amravati University, Amravati, Maharashtra, India

Correspondence
Lalit S Sharma
Research Scholar, Sant Gadge Baba Amravati University, Amravati, Maharashtra, India

Exploring the impact of plyometric exercises on speed development in handball players from SGBAU, Amravati

Lalit S Sharma

Abstract
The primary objective of the current investigation is to assess the impact of plyometric exercises on the augmentation of speed among female handball players. The study comprises a sample of 20 participants affiliated with SGBAU, Amravati, Maharashtra. This sample is further divided into two groups: the Experimental Group, consisting of 10 individuals, and the Control Group, also comprising 10 participants. Plyometric exercises, including hopping, bounding, depth jumps, tuck jumps, and pushups, were administered to the Experimental Group on alternate days, totaling three sessions per week. Conversely, the Control Group underwent conventional training over the course of 6 weeks.
Pre-test and post-test evaluations were conducted using a 30-meter run to quantify the speed of both the Experimental and Control Groups. The outcomes of this study reveal a noticeable improvement in the speed performance of the Experimental Group following the implementation of plyometric training. In contrast, the Control Group exhibited a decline in speed performance.
Conclusively, the findings suggest that plyometric exercises contribute significantly to the enhancement of speed among female handball players. This underscores the efficacy of incorporating plyometric training methodologies to foster improvements in the athletic capabilities of handball athletes.

Keywords: Bounding, hopping, plyometric exercises speed

Introduction
Plyometrics, also known as “jump training” or “plyos,” are exercises based around having muscles exert maximum force in short intervals of time, with the goal of increasing both speed and power. This training focuses on learning to move from a muscle extension to a contraction in a rapid or “explosive” manner, for example, with specialized repeated jumping.
Plyometrics is defined as the exercises that enable a muscle to reach maximum force in a short period of time. Plyometric training is a series of explosive body weight resistance exercises using the stretch-shortening cycle (SSC) of the muscle fibre to enhance physical capacity such as increasing musculotendinous stiffness and power. It is a quick, powerful movement involving pre-stretching the muscle tendon unit followed by a subsequent stronger concentric contraction. This process of muscle lengthening followed by rapid shortening during the SSC is integral to plyometric exercise. The SSC process significantly enhances the ability of the muscle-tendon unit to produce maximal force in the shortest amount of time. These benefits have prompted the use of plyometric exercise as a bridge between pure strength and sport-related power and speed. Plyometric exercise is a popular form of training used to improve athletic performance.
Plyometric drills encompass rapid and forceful movements, incorporating a pre-stretch or countermovement that engages the stretch-shortening cycle. Traditional plyometric exercises encompass a diverse range of jump training techniques and upper body drills utilizing medicine balls. Plyometrics stand as an apt form of power training applicable to both team-based and individual sports. While some may perceive it merely as a repetitive action of jumping, it is crucial to recognize that the optimal safety and effectiveness of plyometrics hinge upon the meticulous adherence to essential guidelines and intricately designed program protocols.

These measures are imperative to ensure that the integration of plyometric training achieves the highest level of safety and efficacy possible.

History of plyometrics

Originally referred to as the "Stretch Shortening Cycle" or "Jump Training," this concept was articulated by the eminent Russian national jump coach, Mr. Yuri Verkhoshansky. The nomenclature "Plyometrics" was later introduced by the accomplished former athlete and American track and field coach, Mr. Fred Wilt. The term itself finds its roots in the Greek language, stemming from "Plyometric," where "Plio/Polythene" signifies more or increase, and "Metric" denotes measurement. Consequently, the term "Plyometrics" encapsulates the essence of "increasing the measurement," reflecting the fundamental objective of this training methodology.

Models of plyometrics

Mechanical Model

Within this model, the generation of elastic energy occurs within the series elastic component (SEC) encompassing both muscle and tendon. This energy is intricately stored through swift stretching movements. Subsequently, this stored energy undergoes release during a concentric muscle action, facilitated by the concentric component (CC), which includes elements such as actin, myosin, and cross-bridges. These components collectively contribute to the overall force production within the muscle, elucid.

Neurophysiological Model

This model is based on the concept of stretch reflex.

Stretch reflex is the body's involuntary response to an external stimulus that stretches the muscle and the stretch receptors. Stretching of the muscle spindles causes a reflex contraction of the stretched muscle. Additionally, Golgi Tendon Organs inhibit the muscle action if the muscle tension increases.

Stretch Shortening Cycle

The SSC is a combination of both the models previously mentioned i.e. the mechanical model and the neurophysiological model and it forms the basis of Plyometrics. It incorporates both, the storage of energy in the Series Elastic Complex (SEC) and the stimulation of the stretch reflex to facilitate maximum recruitment of muscle units in a short amount of time.

Stretch-shortening cycle consists of three phases

- Eccentric
- Amortization
- Concentric

Eccentric Phase (Loading Phase)

- Pre-stretch of the agonist muscle.
- Elastic energy is stored in the SEC.
- Muscle spindles are stimulated.

Amortization Phase (Coupling Phase)

- It is the time between the end of pre-stretch and the start of concentric muscle action.
- Pause between phase 1 and 3.
- Type 1a afferent nerve fibres from the muscle spindle synapse with alpha motor neuron.
- Ideal coupling phase lasts for 15 milliseconds.

Concentric Phase (Unloading Phase)

- Shortening of muscle fibres.
- Elastic energy is released from the SEC.
- Alpha motor neurons stimulate the agonist muscle group.

Indications

- To maintain high level of functional activity.
- To improve balance and proprioception.
- To increase muscle strength and power.
- To maximize reaction time.
- To maximize efficiency of movements.

Contraindications

- Unconditioned athlete - lack of foundational strength and training.
- Unyielding surface.
- Stress related injury history.
- Acute or sub-acute sprains.
- Acute inflammation.
- Post-operative condition.
- Joint instability.

Ideal plyometrics training program

Targeted Muscle Groups

Lower Extremities

- Gluteal muscle group.
- Hip flexor group.
- Quadriceps muscle group.
- Hamstring muscle group.
- Gastrocnemius.
- Anterior tibialis.
- Abdominal muscles.

Upper Extremities

- Biceps.
- Triceps.
- Deltoids.
- Trapezius.
- Rotator cuff muscles.
- Scapular stabilizers.
- Latissimus dorsi.
- Spinal erector muscle group.

Mode

Lower Body Plyometrics

These are appropriate for virtually any athlete and any sport. E.g.: Football, Basketball, Rugby, etc. The direction may vary from sport to sport, but most of them require the athletes to produce quick and maximal vertical or horizontal movements. These are usually exercises involving jumping, bounding or hopping.

Examples of lower extremity plyometrics

- Jumping in place.
- Box drills.
- Bounds.
- Drop jumps.

Upper Body Plyometrics

These exercises are best suitable for sports that involves more of upper body demand. Eg. Cricket, Badminton, Tennis, etc.

Examples of upper limb plyometrics

- Ball throws.
- Kettle bell swing.
- Ball catches.

- Push ups.

Trunk Plyometrics

The core often plays a double role; one involving dynamic movement (provided by the outer core muscles) and the other providing strong static stability (provided by the inner core muscles). Thus these muscle groups also have to be trained along with the upper and lower extremity.

Examples of trunk plyometrics

- Crunches.
- Russian twists.
- Seated medicine ball pass.
- Standing rotational ball pass.
- Prone push pass.

Combination Plyometrics Exercise

It is important to combine movements to better prepare athletes for the demand of their sports. A typical athlete may run, change directions, jump and throw a ball in a matter of seconds thus it is necessary to train these combination of movements in an athlete. These combinations not only produces significant results but it also makes the training session enjoyable.

Some examples of combination

- Combining variety of jumps.
- Jump and throw.
- Throw and sprint.
- Jump and sprint.
- Jump and throw, etc.
- (Be creative).

Intensity

Plyometric intensity refers to the amount of stress placed on the muscles, connective tissue and joints. Initially the intensity of the plyometric exercises should be low. Gradual progression should be made in the intensity, complexity and the difficulty of the exercises.

Factors affecting the intensity

- Speed.
- Body weight.
- Point of contact.
- Height of the drill.

Frequency and Duration

Plyometrics exercises place a high demand on the athletes' body thus adequate rest must be provided for the body to recover from the excessive load. Typical recovery time is between 48 to 72 hours. Thus, the frequency of plyometrics training is two to three sessions per week. Each session should last for one hour which includes 15 minutes of warm up, 20 to 30 minutes of plyometric training and 15 minutes of cool down.

Volume

For lower body the volume is measured by the number of contacts per workout session. Whereas for upper body, volume is expressed in number of throws/catches per session. As the training progresses the volume must be increased.

Progression

Plyometrics is a form of resistance training thus the progression should follow principle of progressive overload.

The progression should be

- Bilateral to unilateral.
- Stable to unstable.
- Symmetric to unsymmetrical.
- Simple to complex.
- Low intensity to high intensity.
- Combination of movements.
- Change of surface.
- Add barriers (Such as cones, hurdles, boxes, etc.).

Program Length

Currently, most of the basic plyometrics program range from 4 weeks to 6 weeks. Advanced plyometric exercises program can range from 12 weeks to 18 weeks. During the advance phase, progression and combination of plyometrics with other training form should be done.

Equipment, surfaces and footwear

Equipment

Selection of plyometric training equipment must be done based on the type of exercise and the intensity. Equipment should be modifiable to suit the needs of individual athletes as no two athletes are the same.

Examples of equipment

- Plyometric boxes.
- Hurdles.
- Medicine balls.
- Barbells/dumbbells/kettle bells.
- Resistance bands.
- Weighted vests.

Surfaces

The choice of training environment has a major impact on the effects of plyometrics exercise both in training specificity and injury prevention. The hardness of the surface can affect the amortization phase by increasing or decreasing the ground-contact time i.e., softer training surface causes higher contact time. On a softer surface the body stiffens whereas on a harder surface the body softens the connective tissue to absorb the impact and prevent injury. For athletes, It is advised to train on a relatively softer surface for major part of the training season to prevent soft tissue injury and maintain peak health during high-volume preparatory period.

Some examples of training surfaces

- Sand.
- Grass.
- Artificial turf.
- Indoor wooden courts.
- Rubberized track and flooring.

Footwear

The choice of appropriate footwear for any training program can be critical in both performance and health.

Functions of a footwear

- Protect the feet from daily wear and tear.
- Deliver impact that produces strides, jump, change in direction.
- Sensory feedback.
- Shock absorption.

A good footwear should consists of

- Proper covering of the foot.
- Proper cushioning.

- Thicker heel.
- Good ankle stability.

When transitioning form early preparatory phase to pre-competitive phase the training must be carried out in the shoes that will be used for the sport. Eg: spikes for track and field athletes, cleats for soccer, rugby baseball players, court shoes for racket sports, basketball and volleyball, etc.

Safety and Pre-training Considerations

Pre Training Considerations

Criteria to begin plyometric training

- **Strength:** 80% to 85% of strength / MMT OF 4/5 for injured muscles and 5/5 for all other muscles.
- **Range:** 90% to 95% of range of motion.
- **Load:** Initial load must be 30% of 1 RM.
- **Speed:** Drills must be performed quickly but safely.
- **Rate:** The rate of stretch is more important than the length of stretch.
- **Frequency:** Plyometrics should not be performed more than 4 times a week.
- **Intensity:** When intensity is high volume should be reduced.
- **Body awareness:** Coordination, balance, body control.

Safety

- Evaluate the athlete thoroughly.
- Ensure the facility, environment and equipment are safe.
- Establish sports specific goals.
- Teach the athlete proper technique.
- Always perform the exercises under supervision.
- Proper progression of the program.
- Soccer specific plyometric training program.

Summary

- In conclusion, Plyometric training is a series of explosive body weight resistance exercises.
- Based oh stretch shortening cycle which consists of three phases; eccentric contraction, amortization and concentric contraction.
- Plyometric training can be done for the upper extremity, lower extremity and the trunk.
- Adequate recovery time must be provided.
- Sports specific program design should be developed.
- Training should be done on appropriate surface with proper footwear and equipment.
- Precautions must be taken for the safety of the athlete.

Methods

Plyometrics find their primary application among athletes, particularly martial artists, sprinters, and high jumpers, aiming to enhance overall performance. While their utilization in the fitness domain is relatively less pronounced, the current study seeks to explore the impact of plyometric exercises on speed development specifically within the realm of basketball players. The study sample comprises 20 female handball players from SGBAU, Amravati, Maharashtra, with ten participants allocated to both the experimental and controlled groups.

The experimental group underwent plyometric exercises such as hopping, bounding, depth jumps, tuck jumps, and pushups on alternate days, encompassing three sessions weekly. In contrast, the controlled group received general training over the course of 6 weeks. To assess the efficacy of the intervention, pre-test and post-test evaluations were conducted through a 30-meter run, targeting the measurement of speed within both the experimental and controlled groups.

Results

The study outcomes indicate that the Experimental Group experienced an advancement in speed attributed to the incorporation of plyometric training. Conversely, the controlled group exhibited a decline in speed performance, a consequence of the general training regimen, as elucidated in Table 1.

Table 1: Mean values of 30 m run test between experimental and control groups of handball players

Variables	Group	Pre-test Mean	Post-test Mean	t	P-value
30 m run test	Experimental	4.61	4.20	2.58	0.000
	Control	4.66	4.73		

The pre-test results for the experimental group in the 30m run indicated a mean of 4.61, while the controlled group showed a mean of 4.66. In the post-test, the experimental group exhibited a reduced mean of 4.20, whereas the controlled group showed an increased mean of 4.73. This signifies an improvement of 0.41 in the experimental group's performance from pre-test to post-test, while the controlled group experienced a marginal increase of 0.07.

Conclusion

In conclusion, the plyometric training implemented resulted in a significant enhancement in speed among the handball players. Plyometric exercises, which involve dynamic movements like jumping, contribute to the effective completion of the stretch-shortening cycle, impacting muscles, the nervous system, and connective tissues. The National Strength and Conditioning Association recognizes the benefits of such exercises for athletic performance. For handball players, integrating upper and lower body plyometrics into their routine can enhance throwing and dribbling power, agility, and the ability to swiftly change directions.

Recommendations

Similar studies can be conducted on men Handball players and other sports and games. The coaches can prepare the program for the development of speed and other motor qualities in Handball players.

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