What Is Plyometrics?

- Goal of Plyometrics
  - Decrease amount of time required between the eccentric m. contraction & the initiation of the overcoming concentric contraction
  - Normal physiological movement rarely begins from a static starting position, but is usually preceded by an eccentric pre-stretch

- Utilizes the series-elastic & stretch reflex properties of the neuromuscular unit
  - Stretch-shortening (rapid eccentric loading phase-concentric phase) cycle
    - Stimulates the proprioceptors of the excitability of the neuromuscular receptors
    - Improves the reactivity of the neuromuscular system
  - Amortization phase - phase between the stretch & shortening cycles, must be kept very brief (capitalizes on ↑ tension in the muscle)

What Is Plyometrics?

- High-velocity resistance training characterized by a rapid eccentric contraction followed immediately by a rapid reversal of movement w/ a concentric contraction of the same muscle
  - High velocity eccentric to concentric muscle loading, reflexive reactions, & functional movement patterns

- Form of Resistance training & Power training

- Main purpose - heighten the excitability of the nervous system for improved reactive ability of the neuromuscular system

History of Plyometrics

- Eastern Europe
- "Jump Training"
- Fred Wilt - American track & field coach named it
- Plyo – means "to increase"
- Metric – means "to measure"
- Definition - quick, powerful movement involving pre-stretching the muscle & activating the stretch-shortening cycle to produce stronger concentric contraction

- Late 1960's-early 1970's - Eastern Bloc countries dominated Olympics
- After 1972 Olympics, articles appeared about new system of jumps & bounds
- Jump roping & bench hops were used to improve quickness & reaction time
Plyometrics

- Sources for Resistance
  - Body weight
  - External forces
    - Elastic tubing
    - Elastic bands (Theraband)
    - Weighted ball

**Neurological & Biomechanical Influences**

- Muscles have a natural tendency to rebound when stretched rapidly (e.g. rubber band)
  - **Theoretically, the more rapid the eccentric contraction, the more likely the stretch reflex is activated**
- For an activity to truly be plyometric, there must be a movement preceded by an eccentric muscle action.
- Plyometric training can promote changes within the neuromuscular system that allow the person to have better control of the contracting muscles.

**Three phases of the Stretch-Shortening Cycle (SSC)**

- Eccentric phase
- Amortization phase
- Concentric phase

**Stretch cycle (eccentric)** - prepares the contractile elements for a shortening cycle (concentric)
- Stimulates & activates the monosynaptic stretch reflex
- Muscle spindles, lying parallel w/ m. fibers, sense the length of the muscle & velocity of stretch, & transmit this info to CNS
- Impulses sent back from CNS to muscle facilitates reflexive shortening contraction of the stretched muscle

**Neurological & Biomechanical Influences**

- Stretch reflex - most basic sensorimotor response system - goes directly from afferent sensory nerves (m. spindle) to spinal cord to make contact with efferent motor neuron to permit rapid response by muscle
  - Also referred to as Monosynaptic response
  - Fastest reflex in body
- Contractile elements (CC) - myofibrils, sarcomeres (contractile element of muscle)
  - Muscle - only structure in the body that actively shortens/lengthens
- Non-contractile elements - tendons, CT surrounding muscle & fibers
  - Series Elastic Component (SEC) - Tendons, Sheath, Sarcolemma
  - Parallel Elastic Component (PEC) - Muscle, CT
Neurological & Biomechanical Influences

- When muscle actively shortens, the component responsible is CC.
- When muscle actively lengthens, components responsible for producing force are CC, SEC, & PEC.
  - SEC & PEC offer resistance to movement as muscle is elongated.
  - CC controls speed & quality of movement.
- GTOs play inhibitory role in muscle activity
- As muscle shortens, GTOs are stimulated to send impulses to spinal cord that relay facilitation to limit muscle force production
- It’s believed that during plyometrics, GTOs excitatory level is ↑ so that more stimulation is necessary to facilitate a response from GTO, allowing for ↑ tolerance for additional stretch

As stretch loads are better tolerated, there may be an ability to create a stronger stretch reflex that results in ↑ power during the concentric phase

If the Amortization phase is prolonged, it inhibits the stretch reflex and the heat generated is dissipated & wasted

Plyometric Force Production

Think of the Rubber band:
- The greater the stretch, the greater the quantity of stored (potential) elastic energy there is.
- Stored elastic energy converts to kinetic energy
- Plyometrics work because transfer of elastic energy that is produced during eccentric activity goes to power of the concentric activity
  - The load produced with lengthening is stored in non-contractile elements

Remember: Force production is different for Concentric & Eccentric activity:
- Concentric – all active components must produce force
- Eccentric part active produce force, part passive produce force (muscle works less to produce same force)

Plyometric Effectiveness

Important factors in ↑ strength & power output
- Development of neuromuscular responses to stresses applied
  - GTOs thresholds are raised to permit more stretch
- ↑ neuromuscular coordination
  - As speed ↑ & activity is performed more accurately, the strength to perform is improved. Energy & movement are not wasted on ineffective activity. Better coordination permits greater power production
- When speed & coordination of activity is improved, greater power can be produced
- RATE of stretch is more important than AMOUNT of stretch
Program Development – Pre-requisites

- Appropriate only in later stages of rehabilitation
- Must have a good base of m. strength, endurance & flexibility
- Specificity of training
  - Break down & analyze the basic movement patterns of the sport
  - Include open & closed kinetic chain exercises
- Lower extremity biomechanics should be sound to ensure a stable base of support & normal force transmission
  - Biomechanical abnormalities are not contraindications for plyometrics, but can contribute to stress failure-overuse injury
- Perform functional tests to screen for adequate strength base before beginning plyometrics
  - Power squat – perform 5 squats @ 60% body weight in 5 sec.

Stability testing
- Static stability
  - SL stance – 30 sec eyes open, eyes closed
  - SL ¼ squat – 30 sec eyes open, eyes closed
  - SL ½ squat – 30 sec eyes open, eyes closed
- Dynamic movement testing
  - Vertical or single leg jumping for distance – 85% passing score
  - Like our functional hop test
- Flexibility
  - General & Specific flexibility

Program Design

- Consider age, body weight, competitive level, surface, footwear, proper technique, progression, & goals when developing a program
- Direction of Body Movement
  - Horizontal body movement is less stressful than vertical movement
  - Dependent upon weight of athlete & technical proficiency demonstrated during jumps
- Weight of Athlete
  - The heavier the athlete, the greater the training demand placed on the athlete
- Speed of Execution of Exercise
  - ↑ speed of execution on exercises (SL hops, alternate-leg bounding) raises the training demand on the individual
- External Load
  - Adding an external load can significantly ↑ the training demand
  - Do not raise the load to a level that will significantly slow the speed of movement

Intensity
- Amount of effort exerted
  - Can be controlled by type of exercise performed (DL jumping - less stressful than SL jumping)
  - Progress from simple to complex activities
  - Adding external weight or raising box height increases intensity

Volume
- Amount of work performed during one session
  - Total # of foot contacts in one session
  - Beginners – 75-100 foot contacts/session
  - Advanced – 200-250 foot contacts/session

Frequency
- Optimum frequency is suggested that 48-72 hours of rest are necessary for full recovery
Program Design

- **Training Age**
  - Younger ages – overall training demand should be kept low
  - Youth sports involve plyometric movements
  - Research has shown that plyometric training in youth does result in strength gains & increases bone mineral content in females

- **Recovery**
  - Rest time between exercise sets
  - Longer recovery period should be used to allow restoration of metabolic stores because plyometrics is anaerobic in nature
  - Power training – work rest ratio 1:3 or 1:4
  - Endurance training – 1:1 or 1:2 ratio

Precautions & Contraindications

- **Precautions**
  - Time
  - DOMS

- **Contraindications**
  - Acute inflammatory condition
  - Post-operative conditions
  - Instability

Classification of Individuals

- Beginner
- Intermediate
- Advanced

  Now you can begin to develop and initiate a program

Plyometric Categories

- In-place jumping
- Standing jumps
- Multiple-response jumps & hops
- In-depth jumping & box drills
-Bounding
- High-stress sport-specific drills
Equipment

- Cones
- Agility Ladder
- Boxes
- Hurdles
- Medicine balls
- Tubing

Instructions for Performing Plyometrics

- Lower extremity
  - Feet should be nearly flat in all landings
  - Individual should be encouraged to “touch & go”
  - Reverse the landing as quickly as possible, spending minimal time on the ground

Success of a Program

- Depends on how well the training variables are:
  - Controlled – be flexible & listen to body
  - Modified
  - Manipulated

- In general, as intensity of exercise increases, volume is decreased (& vice versa)

- Should follow a periodization period
  - 4 phases of year-round periodization
    - Competitive season, Postseason training, Preparation phase, Transitional phase

- Plyometrics should be performed in latter stages of preparation phase & during transitional phase for optimal results & safety

To Gain Optimal Benefits of a Plyometric Program

- Individual should
  - Be well conditioned with sufficient strength & endurance
  - Exhibit athletic abilities
  - Exhibit coordination & proprioceptive abilities
  - Free of pain from any injury or condition

- Plyometrics are not designed to be an exclusive training program
Upper Extremity Plyometric Drills

I. Warm-up drills
- Plyoball trunk rotation
- Plyoball side bends
- Plyoball wood chops
- ER/IR with tubing
- PNF D2 pattern w/ tubing

II. Throwing Movements - Standing Position
- 2-hand chest pass
- 2-hand side throw overhead
- Tubing ER/IR (both @ side & 90° abduction)
- Tubing PNF D2 pattern

II. Throwing Movements - Seated Position
- 2-hand overhead throw
- 2-hand side-to-side throw
- 2-hand chest pass
- 1-hand baseball throw

III. Trunk Drills
- Plyoball sit-ups
- Plyoball sit-up & throw
- Plyoball back extension
- Plyoball long sitting side throws

IV. Partner Drills
- Overhead soccer throw
- Plyoball back-to-back throws
- Overhead pullover throw
- Kneeling side throw
- Backward throw
- Chest pass throw

V. Wall Drills
- 2-hand chest throw
- 2-hand overhead soccer throw
- 2-hand underhand side-to-side throw
- 1-hand baseball throw
- 1-hand wall dribble

VII. Endurance Drills
- 1-hand wall dribble
- Around-the-back circles
- Figure-8 through the legs
- Sing-arm ball flips

Lower Extremity Plyometric Drills

I. Warm-up Drills
- DL squats
- DL leg press
- DL squat-jumps
- Jumping jacks

II. Entry Level Drills - 2-legged
- 2-legged drills
- Side-to-Side (floor/line)
- Diagonal jumps (floor/4 corners)
- Diagonal zig-zags (6 spots)
- Plyo leg press
- Plyo leg press (4 corners)

III. Intermediate Level Drills
- DL box jumps
- 1-box side jumps
- 2-box side jumps
- 2-box side jumps w/ foam
- 4-box diagonal jumps
- 2-box jumps w/ rotation
- 1/2 box w/ catch
- 1/2 box w/ catch (foam)
- SL movements
- SL plyo leg press
- SL side jumps (floor)
- SL side-to-side jumps (floor/4 corners)
- SL diagonal jumps (floor/4 corners)

IV. Advanced Level Drills
- SL box jumps
- 1-box side jumps
- 2-box side jumps
- SL plyo leg press (4 corners)
- 2-box side jumps w/ foam
- 4-box diagonal jumps
- 1-box jumps w/ rotation
- 1-box jumps w/ catch
- 1-box side jump rotation w/ catch
- 2-box side jump w/ catch
- 2-box side jump rotation w/ catch

V. Endurance/Agility Plyometrics
- Side-to-Side bounding (20 feet)
- Side jump lunges (cone)
- Side jump lunges (cone w/ foam)
- Altering rapid step-up (forward)
- Lateral step-overs
- High stepping (forward)
- High stepping (backwards)
- Depth jump w/ rebound jump
- Depth jump w/ catch
- Jump & catch (plyoball)
Guidelines for Plyometric Programs

- Sound technical foundation
- Should be specific to the goals of the athlete
- Quality of work is more important than quantity of work
- The greater the exercise intensity level, the greater the recovery time
- Plyometric training can have its greatest benefit at the conclusion of the normal workout
  - Best replicates exercise under a partial or total fatigue environment
- When proper technique can no longer be demonstrated, max. volume has been achieved & the exercise must be stopped

Guidelines for Plyometric Training

- Activities should be progressive in nature
- Volume & intensity can be modified by:
  - Increase # of exercises, # of reps & set, decrease rest period between sets
- Sessions should be conducted no more than 3 times weekly in the preseason phase of training (volume should prevail). During competitive season, frequency should be reduced to twice weekly with intensity more important
- Test dynamically to provide progression & motivational feedback
- The KEY element in execution of proper technique is the eccentric or landing phase

Plyometrics in Rehabilitation

- Clinical plyometrics can be categorized according to the loads applied to the healing tissue
  - Medial/lateral loading
  - Rotational loading
  - Shock absorption/deceleration loading
- Plyometrics can be further categorized into
  - In-place activities
  - Dynamic distance drills
  - Depth jumping
    - Simple jumping drills (bilateral) → hopping drills (unilateral)

Medial-Lateral Loading

- Cutting activities, varus & valgus stresses
- Should be implemented following injury to medial & lateral complexes
- Progress from bilateral to unilateral activities
- Slideboard, lateral bounding, crossovers
Rotational Loading

- Places stresses on cruciate ligaments, menisci, capsule
- Spin jumps, lateral hopping

Shock Absorption (Deceleration) Loading

- Place stresses on muscles, tendons, articular cartilage
- Final preparation for return to sports
- Repetitive jumping, five-dot drill, jump downs

Proper Plyometric Landing Position

Lower-Body Plyometric Drills: Jumps in Place
Two-Foot Ankle Hop

Intensity Level: Low
Lower-Body Plyometric Drills: Jumps in Place

Squat Jump

Intensity Level: Low

Jump and Reach

Intensity Level: Low

Double-Leg Tuck Jump

Intensity Level: Medium

Split Squat Jump

Intensity Level: Medium

After completing a set, rest and switch front legs.
Lower-Body Plyometric Drills: Jumps in Place

Cycled Split Squat Jump
Intensity Level: High

Single-Leg Tuck Jump
Intensity Level: High

Pike Jump
Intensity Level: High

Lower-Body Plyometric Drills: Standing Jumps

Double-Leg Vertical Jump
Intensity Level: Low
Lower-Body Plyometric Drills: Standing Jumps

Jump Over Barrier

Intensity Level: Medium

The softer surface shown above will minimize harmful impact force, while still providing a SSC overload.

Lower-Body Plyometric Drills: Standing Jumps

Single-Leg Vertical Jump

Intensity Level: High

Lower-Body Plyometric Drills: Multiple Hops and Jumps

Double-Leg Hop

Intensity Level: Medium

Jump as far forward as possible.

Lower-Body Plyometric Drills: Multiple Hops and Jumps

Double-Leg Zigzag Hop

Intensity Level: High
**Lower-Body Plyometric Drills:**
*Multiple Hops and Jumps*

**Single-Leg Hop:** Repeat the hop using the same leg.

*Intensity Level: High*

**Front Barrier Hop**

*Intensity Level: Medium*

**Lateral Barrier Hop**

*Intensity Level: Medium*

**Skip**

*Intensity Level: Low*
Lower-Body Plyometric Drills: Bounds

**Power Skip**

Intensity Level: Low

**Backward Skip**

Intensity Level: Low

**Single-Arm Alternate-Leg Bound**

Intensity Level: Medium

**Double-Arm Alternate-Leg Bound**

Intensity Level: Medium
Lower-Body Plyometric Drills: Box Drills

Single-Leg Push-Off

Intensity Level: Low

Alternate-Leg Push-Off

Intensity Level: Low

Lateral Push-Off

Intensity Level: Low

Side-to-Side Push-Off

Intensity Level: Medium
Lower-Body Plyometric Drills: Box Drills

Jump to Box

Intensity Level: Low

Squat Box Jump

Intensity Level: Medium

Lower-Body Plyometric Drills: Box Drills

Lateral Box Jump

Intensity Level: Medium

Jump From Box

Intensity Level: Medium
**Lower-Body Plyometric Drills: Depth Jumps**

**Depth Jump**

Step from box.

**Intensity Level: High**

**Depth Jump to Second Box**

**Intensity Level: High**

**Squat Depth Jump**

**Intensity Level: High**

**Depth Jump With Lateral Movement**

**Intensity Level: High**
Lower-Body Plyometric Drills: Depth Jumps
Depth Jump With Standing Long Jump

Intensity Level: High

Lower-Body Plyometric Drills: Depth Jumps
Single-Leg Depth Jump

Intensity Level: High

Upper-Body Plyometric Drills: Throws
Chest Pass

Intensity Level: Low

Upper-Body Plyometric Drills: Throws
Two-Hand Overhead Throw

Intensity Level: Low
Upper-Body Plyometric Drills: Throws

Two-Hand Side-to-Side Throw

Intensity Level: Low

Single-Arm Throw

Intensity Level: Medium

Power Drop

Intensity Level: High

Depth Push-Up

Intensity Level: Medium
Trunk Plyometrics
45-Degree Sit-Up

Intensity Level: Medium