BUILDING BONES:

A PLYOMETRICS MANUAL FOR GIRLS

By

ALEXANDRIA ELYSE BOYD

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With Honors in

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Approved by:

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Dr. Scott Going

Department of Nutritional Sciences

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PART I
PHYSIOLOGY OF BONE

Bone Basics: A Better Understanding

Bone takes on the principle responsibility of supporting loads that are imposed upon it. Its weight is composed of 25% organic components, 70% inorganic components, and 5% water. The organic component consists of type I collagen, bone cells, and noncollagenous protein. This portion of bone determines the structure, mechanical, and biochemical properties. Small gaps within and between collagen molecules permit biological activity to take place. The organic segment gives bone its flexibility and compressibility, or tensile strength. This means that when force is placed on the bone, it illustrates elasticity, allowing for a slight degree of bend. Due to this organic fraction, impressive amounts of force can be applied to the bone without injuries that a completely rigid bone might incur. The specific maximum force that can be placed upon a bone without injury depends on bone diameter and density. Gradually exposing bone to greater forces over time can build up this bone strength. In other words, bone strength is a positive feedback cycle. The greater the force placed on bone, the stronger the bone becomes, thus allowing for even greater forces to be applied. This is precisely why exercise is key to healthy bones, as it provides the necessary forces that must be applied to bone to become stronger.

Bone's inorganic component is made up of mineral, mainly crystalline calcium hydroxyapatite. This facet of the bone is found in and around the collagen fibers of the organic component. Optimal crystal size, amount, and distribution are

important for the strength of the bone, as they lead to mineral hardness and rigidity. Rather than the positive feedback shown in organic materials, a negative feedback cycle is used within the inorganic aspect. Bone serves as a generous reservoir for the central pool of calcium, and uses the alimentary tracts and kidneys to regulate calciotropic hormones. If calcium plasma levels are lower in the blood, then a greater amount of hormones will be secreted. If blood calcium levels are insufficient, the calciotropic hormone PTH will be secreted, resulting in dips in calcium stores in the bone. Bone calcium is removed to utilize within the blood, thus leaving a weakened bone. This inorganic component is not as much affected by exercise, but rather by diet. Proper calcium intake is vital in order to supply enough for both blood and bone.

There are three main areas of bone physiology. The first is calcium homeostasis, which was touched upon when discussing the inorganic portion of bone. A vast majority, in fact 98%, of total body calcium exists within the bone. Thus, hormones such as PTH and Vitamin D, which affect serum calcium levels, are key in influencing bone mineralization.

The second area in connection with bone physiology is mechanotransduction, which refers to the mechanisms by which cells can convert a mechanical stimulus into chemical activity. This makes reference back to the organic part of the bone and the role that physical activity plays on the skeleton. When a force is generated on the skeleton, it creates a force on the individual bones making up the skeleton, and thus the osteoblast cells that constitute bone. Consequently, osteoblast gene expression is changed and bone-lining cells are reverted to additional osteoblasts. A second pathway is also activated, utilizing second messengers which stimulate further osteoblast activity. While laying down new bone, osteoblasts also communicate the message of loading to osteocytes. The osteocytes, in turn, produce anabolic growth factors that are transferred to the bone surface and recruit osteoprogenitor, or bone precursor cells. These precursor cells can then mature into future osteoblasts and osteocytes.

Mechanotransduction influences groups of cells to act in coordinated cell action, leading to the third focal area, that of modeling and remodeling. The growing skeleton is dominated by bone modeling, or creating new bone. Meanwhile, the nongrowing skeleton of adult years is dominated by remodeling as old bone is broken down and reformed. Modeling adjusts bone strength through strategically placed bone mass, maximizing rigidity while simultaneously minimizing malleability. There are two independent actions involved, that of osteoblasts, which initiate bone formation, and of osteoclasts, which lead to bone resorption. This means that bone formation and resorption may occur on different surfaces.

The remodeling mechanism repairs damage incurred on bone, preventing future injury. It creates new bone when harmed tissue needs to be replaced. This process involves the coupling of bone formation and bone resorption and consists of five phases. The first is activation, involving the stimulation and differentiation of preosteoclasts into mature osteoclasts. Next, resorption takes place as osteoclasts digest the mineral matrix of old bone. Thirdly, reversal leads to the end of resorption. The fourth phase, formation, consists of osteoblasts synthesizing new bone matrix. Finally, quiescence takes place, allowing osteoblasts to become resting bone lining cells on the newly formed bone surface.

This is an especially relevant area when examining how plyometrics can positively affect bone strength. When forces are placed on the body by plyometrics, such a body weight during the landing phase of a jump, they use mechanotransduction to turn the mechanical signal of the force into chemical activity. This chemical stimulus communicates with osteoblasts, signaling for the creation of more bone in order to better handle the force being placed upon the body. Thus, the bone becomes stronger.

Periosteal expansion and endosteal contraction are two potential results of bone growth that occur on separate surfaces of the bone. Periosteal expansion is essentially added bone mass onto the outside surface of the bone. On the contrary,

endosteal contraction is the result of additional bone mass on the internal surface. As bones begin to decrease in density, the mass is taken away from the inner portion, thus hollowing out the bone. Thus, the greater starting mass on the endosteal surface, the greater amount that can be lost before becoming weak. As bones develop during the growing stages of younger years, additions are made to both the surfaces. After puberty ends, mass will no longer be added to the periosteal surface of the bone. Thus, the diameter of the bone cannot increase further.

It is within these three key components of bone functionality that bone health can be maintained. In order to affect bone in a positive way, methods by which to improve these constituents must be learned and followed. It is clear that both diet and physical activity contribute to preserving and improving the skeletal system. A balanced and intelligent diet aids in the first area of concern, which is that of calcium homeostasis or mineralization. However, the point of interest at hand is focusing on enriching mechanotransduction, modeling, and remodeling. For these purposes, physical activity will serve as the focus.

Strong bones are important for a healthy, mobile lifestyle. They allow for a high quality of life, facilitating physical activity in the young while sustaining mobilization in the elderly. Thus, it is of utmost importance to take care of the skeletal system by living a lifestyle conducive to healthy bones. Bone mass is one of the main determinants of bone material properties and strength. How mass is distributed among the geometrical bone design is directly connected to bone strength and solidity. Meanwhile, the geometry of the bone is of great significance as well. Characteristics that contribute to geometry include size, shape, width, and microarchitecture. Thus, increases in diameter and cross-sectional area lead to improvements in overall bone mass, ultimately resulting in positive adaptations in bone strength.

Strain must initially be placed on a bone in order for it to become stronger. However, a resulting increase in bone strength will then reduce the magnitude of

strain perceived by the skeleton when further placed under this same load. Additionally, the greater mass of this newly altered bone will bend less in response to the same given load. Conversely, when bone is not exposed to high loads, such as within a sedentary lifestyle, bone mass is diminished.

The skeleton's reaction to a load depends on the magnitude, rate, distribution, and cycles of the strain placed on the target bone. The higher the force enacted on the bone, within safe limits, the greater the response. Bone modeling and remodeling stemming from different loads placed on the body contribute to a homeostatic mechanism that regulates functional strains throughout the skeleton. Many various natural forces are exposed to the body on a general basis, such as the pull of gravity, the weight of muscles, and other daily external forces. However, the bones of the skeleton are designed to resist bending loads that can be applied in a number of different ways. In general, bone tissue can handle fairly great loads when applied in a longitudinal direction. It is not until larger forces are placed within the latitudinal plane, or across a bone's surface, that weaknesses are exposed. Thus, bone-loading exercises targeting different angles of the longitudinal direction of skeletal bones, such as plyometrics, can be ideal for building stronger bones.

Breakable Bones: A Rising Epidemic

Bone mass over time forms a curved graph, peaking at one point before starting an irreversible descent. Peak bone mass, occurring in the pubescent years, determines adult bone mineral density, and can only be reached once. In other words, the bone mass achieved in a person's younger years must last them throughout the entirety of their adult life. Since bone loss occurs in elderly years, achieving a high peak bone mass is vital for avoiding osteoporosis and future fracture risks.

Osteoporosis is a disease in which the bones become porous and weak. Possessing a low density, the bones are more likely to break. This disease has become a major public health pandemic, threatening an estimated 44 million Americans. This constitutes 55% of people at or above 50 years of age. In the United States, ten million individuals have already been diagnosed with osteoporosis, while an estimated 34 million more are osteopenic, meaning that they have a bone mass low enough to place them at risk. Generally thought of as a disease for the elderly, osteoporosis can strike at any age. Even more relevant is that 80% of those affected by osteoporosis are women. One out of every two women over age 50 will break a bone in their lifetime due to osteoporosis. This is a staggering rate of 50%, which can hardly be ignored. Osteoporosis was responsible for more than two million fractures stemming from falls in 2005, and with an aging population is expected to rise to more than three million by 2025. The most commonly occurring fracture from osteoporosis is within the hip, and once a fracture has been sustained there is a four times greater risk of incurring a second fracture. An average of 24% percent of these hip fracture patients, aged 50 and over, died within the year following their fracture because of immobility. In 2005, a total of 15,802 persons greater than 65 years died as a result of injuries from falls.

The growing years are the key time to initiate osteoporosis prevention programs. Females carry an even greater osteoporotic risk, since peak bone mineral accrual occurs about one and a half years earlier in girls than in boys and is of a 20% lesser magnitude. This places girls at their peak, meaning the greatest amount of bone mineral they will ever be able to attain, within their teenage years.

Many studies involving various adolescent animal species have shown over 20% increases in cortical thickness and cross sectional area when placed on bone loading exercise routines. Recent studies have since commenced in regards to controlled exercise intervention in girls. Studies that targeted prepubescent to early pubescent children reported significant increases in bone mass. Meanwhile, post

pubertal girls reported no significant bone mass difference. Thus, there is not a more favorable time to start the young girls' plyometrics guide.

PART II

PLYOMETRICS BACKGROUND

A Planned Solution: Prepping Bones

The battle to avoid weakened bones begins at a very early age. Though osteoporosis generally brings to mind the elderly, studies are illustrating that early onset osteoporosis is affecting women at much earlier stages than menopause. Females achieve their peak bone density in their teenage years. For a maximal density to be reached, the years leading up to puberty must be spent actively engaging one's muscles, bones, and joints in physical activity. As young adulthood is reached, bone density loss can gradually commence Girls who have failed to regularly exercise increase their risk of insufficiently establishing the strong bone structure to successfully support them throughout adulthood. School systems generally have certain levels of physical activity set in place for students through physical education classes and allotted recess times. However, these time frames are diminishing, and the proper amount of attention to actual physical activity may not be given. Young females need further motivation and opportunity to reach the levels of exercise and activity necessary to create strong bones. The physical activity guidelines, as set in place by the U.S. government, state that one

hour of exercise should be performed everyday, including muscle strengthening activities three times a week.

Thirty minutes of strenuous activity per day should be the bare minimum, but the time spent engaged in activity does not need to be considered a chore. Plyometrics, the exercise of choice for this training manual, are a successful yet enjoyable method of building bone strength. Many fun activities can suffice as plyometric exercises, such as hopscotch, jumping rope and jumping jacks. Plyometric training typically includes hops and jumps, and targets many areas in which children can see improvement. These exercises have the potential to enhance speed and power, while most importantly aiding in bone strengthening and weight control. When plyometrics are performed, they involve a jumping action that, in turn, enacts a force upon the body. This force is communicated within the body, and can initiate the feedback cycles for the mineral and geometric properties of the bone. Ultimately, this can lead to increased bone strength. Bone strength results from its geometry and density, both of which plyometrics advantageously affects. Though plyometrics increase peak bone density, seeking to supply protection against loss of mass with age, the benefits of its affect on bone geometry carry an even greater advantage. A lasting improvement, bone geometry will not negatively change with age. Thus, the sturdier the microarchitecture established within children during adolescence, gained from the forces applied from plyometrics, the stronger the bones remain during old age.

Behind the Scenes: How Plyometrics Work

When it comes to physical activity, bone loading is the most important factor in creating stronger bones. Thus, it is a necessity that force be enacted, most

preferably stemming from body weight, loading the bones. When utilized correctly, plyometrics can provide the recommended amount of force. Also referred to as jump training, plyometrics, are a group of exercises that enable a muscle to reach maximum force in the shortest possible time. The muscle is loaded with a lengthening eccentric action followed immediately by a shortening concentric action. There are two different reasons why this training creates beneficial results.

The first is predicated upon mechanics. When a muscle is stretched, such as in the lengthening phase of a jumping movement, elastic energy is created and stored within this muscle. The energy is then released upon the release of the stretch into the jump, or the shortening phase of the movement. The action resembles a spring. When the spring becomes stretched, it has built-up potential energy that is given off by the releasing of the spring back to its compact state. The explosive force thus created by the spring's release leads to a force being placed upon the bone as the jump is landed. This force is that which builds bone strength through mechanotransduction.

The second reason is neurophysical, and involves a stretch reflex. When muscles detect a rapid stretch, a protective response involuntarily occurs to prevent overstretching and potential injury. When the muscles shorten again upon release of the stretch, the protective stretch reflex is inhibited, creating an extra force. The result is a more powerful concentric muscle action, or jump. However, the shortening muscle action must occur immediately after the lengthening muscle action, or else the potential energy produced by the stretch reflect is lost. Again, this plyometrics mechanism allows for a beneficial force to be placed upon the bones as they are loaded with body weight upon a jump's landing.

Since first introduced, plyometrics have been used by highly successful athletes and the general public alike. Dating back to the 1960s, jump training was initially utilized by Russia and other Eastern bloc countries as new and unique training techniques for Olympic athletes. As these athletes began to gain notoriety

and success, their training regimens were soon placed in high demand. Tom Landry, the head coach of the Dallas Cowboys during the 1970s and 1980s, took note and introduced these training methods to the United States. The Dallas Cowboys soon saw domination within the National Football League, inspiring further use of plyometrics amongst other professional sport organizations. Ever evolving, plyometric activities began to emerge for usage by nonathletes and children as well. Today, common youth activities such as hop-scotch, jumping rope, and jumping jacks can be characterized as plyometric exercise.

The Purpose of Plyometrics: Relating Exercise to Young Females

Now that the physiology and mechanics behind both bone building and plyometrics are understood, it is important to discuss how the two subjects relate. The jump motion resulting from the eccentric and concentric muscle actions is a coveted movement for athletes within their training regimens, as it leads to improvements in speed and power. However, for the adolescent girl there is a different imperative benefit. It has been concluded from several different studies that plyometric jump training continued over a period of time during prepubescent growth may increase peak bone mass. Furthermore, research has suggested that this improvement in bone mass may stand to serve as an important prevention strategy for osteoporosis. A mere enhancement of 3-5% in bone mineral density is estimated to result in as much as a 20-30% reduction in fracture risk.

What does this significant and vitally important benefit stem from? The key to plyometrics is their classification as a weight-bearing exercise. Children who engage in activities associated with higher loads, such as body weight during a

jumping exercise, have routinely exhibited higher bone mass than youth who partake in activities utilizing lower loads. Multiple research studies involving immature rats, turkeys, and human subjects have seen similar results, pointing out the positive benefits from exercise.

Some safety precautions must be followed and certain guidelines observed before commencing a plyometric training program. Appropriate athletic footwear must be worn to offer support and protection within the joints. It should also be noted that plyometrics should be performed on even surfaces, preferably on a ground that offers a bit of resilience.

The amount of experience held by the young athlete must be considered. The first initials sessions of the program should be used to teach appropriate execution of each drill. Since children have a high learning curve, rapid improvement will result, but only if proper understanding is gained immediately from the beginning. Young females should first develop an adequate baseline of strength, or simply begin plyometric exercises with lower intensity drills. Gradual progression to higher intensity drills may take place over time. When age-appropriate exercises are chosen, such as those found within this manual, plyometric training is a safe and effective form of exercise for children. This style of bone-strengthening training is meant to be fun, and should only be performed when the participant is fresh and energized. Exercise should be concluded upon fatigue, as it is the biggest detractor of execution. When fatigue gets in the way of performance levels and impedes learning, it is time to stop. The importance of an exercise done correctly far outweighs a drill performed at a high repetition, but without precision. As children also possess a shorter attention span, it is best to select only a few exercises at a time to solidly accomplish.

Once the learning phase of plyometric training has been mastered, intensity can start to be increased. Training programs generally call for maximal effort days twice a week. This allows for a recovery period of 48-72 hours between training days. Without a full recovery, the muscular and nervous systems do not have an

ample opportunity to rid the body of fatigue metabolites. Decreases in performance will result, leading to frustration as desired speed, distance, or height will not be achieved. Mental ability to process and learn information will also diminish. In addition to proper rest in between training days, dynamic exercises can also be effective in clearing the body of fatigue acidities. Both walking and jogging serve as active recovery methods between sets or at the end of a training session.

As youth may progress quickly, it is acceptable to increase training to 3 days a week for children. When a proper exercise foundation has been laid, and baseline mental and physical requirements are met, the intensity of the plyometric training program can start to be amplified. Improvements can be noted in the forms of increases in range of motion, height, distance, speed, intensity, and complexity. If other physical activities are also being engaged in by the participant, than it is also satisfactory to use a plyometric routine as a warm-up for these pursuits. This plan is helpful in converting the bone and muscle strength achieved into functional power within athletic endeavors.

PART III

THE PROGRAM

Instructions

The plyometric exercises recommended in this program have been categorized into three groups based upon the complexity of impact each delivers. A beginner, intermediate, and advanced group are color coded by shades of green, yellow, and red. Green represents the beginning group, symbolizing that all exercises are a "go" for everyone. Yellow symbolizes "caution," meaning that these exercises should only be performed when comfortable with the progression they offer from the green group. Finally, the red group represents "stop," and are reserved only for those at an advanced level.

The difficulty of these groups is based on the amount of impact they impose on the bones of the body. The green group offers the lowest impact, and is highly recommended for all beginners during the first weeks of participation in the program. The yellow group provides a slightly higher level of impact, and can be commenced once the exerciser has gained some experience with plyometrics. Finally, the red group delivers the greatest impact, placing a significant load on the bones. When the exercises are performed as recommended in this manual, these exercises provide the best opportunity for bone density to increase.

While the higher impact exercises found in the red group offer the greatest potential for bone strengthening, progression within the program should not be rushed. The beginner and intermediate levels of exercises should not be passed by

unless the participant has prior and ongoing experience in performing plyometrics. The amount of time spent at each level varies depending on skill and comfort level, however it is recommended that at least a 2-3 weeks are spent learning at both the green and yellow levels.

Though the green group includes some exercises that are not primarily considered plyometrics, they are great lead-up activities which will improve strength and overall fitness. Preparing the body for higher impact, these moves are vital precursors to some of the more intense plyometric moves found in the yellow and red groups. Even as the participant progresses on to the yellow and red groups, it is still important to choose 1-2 green moves to perform as a warm-up.

The plyometrics in this guide have also been placed into upper and lower body groupings. Plyometrics should be performed two to three times per week with each session containing 2-3 upper body moves and 2-3 lower body exercises. It is the exerciser's decision in choosing which moves to perform from the given groups. It is a good idea to mix and match so as not to become bored with one routine. Complete three sets of each exercise, with a rest period of approximately thirty seconds to two minutes in between each set. Good luck, and enjoy blazing the trail to better bones.

GREEN GROUP

Choose 2-3 upper and 2-3 lower exercises for 2-3 workout sessions per week. Perform 3 sets of each move, with a rest period of 30 seconds to 2 minutes in-between.

UPPER BODY

- Crab Walk
  - Facing up, walk backwards on hands and feet
  - Cover a distance of approximately 15 yards

- Seal walk
  - Facing down, walk forwards using the hands. Use a mat or towel under the legs as shown in the display picture.
  - Cover a distance of approximately 15 yards

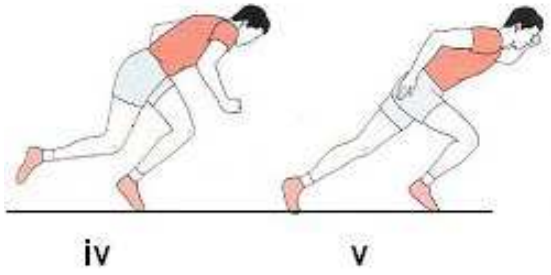
- Bear Walk
  - Facing down, walk on hands and feet
  - Keep the head looking down, and the back slightly hunched
  - Cover a distance of approximately 15 yards

- Dribble a Ball
  - Using one hand at a time, dribble a basketball at waist height
  - Perform for one minute for each hand

LOWER BODY

- Jogging
  - Jog at a moderate exertion level, about 50-60% of maximal speed
  - Make sure to keep limbs moving in a forward direction, eyes looking straight forward
  - Cover a distance of approximately 300 yards

- Sprints
  - Sprint at a high exertion level, about 80-90% of maximal speed
  - Make sure to keep limbs moving in a forward direction, eyes looking straight forward
  - Cover a distance of approximately 40 yards



- Donkey Kicks
  - Facing down, keep hands on the ground while simultaneously kicking both feet up into the air
  - Land back on soles of the feet and repeat
  - Perform 10 repetitions

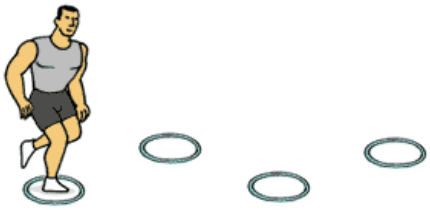
- Butt kicks
  - Quickly alternate kicking one leg at a time backwards far enough to make contact with the gluteal region
  - Perform 10 per leg, totaling 20 repetitions

- High Knees
  - Alternate pulling up one knee at a time, quickly alternating
  - Perform 10 per leg, or 20 total repetitions

- Skips
  - Alternate raising each knee up, kick out while making a small hop with the back foot
  - Cover a distance of approximately 30 yards

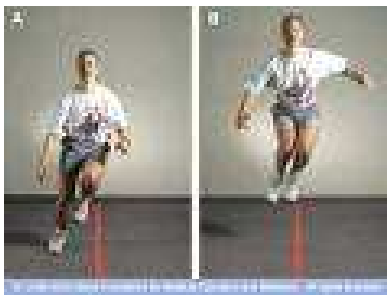
- Frankenstein walk
  - Keeping arms straight out in front of the body, alternate kicking one straight leg up at a time, touching the hand to the toe of the foot
  - Cover a distance of approximately 30 yards

- Tire jumps
  - Use hula hoops or another ring-shaped object to create the set-up shown below, hop from one tire to the next, alternating feet
  - Once the 4th tire is reached, repeat going backwards
  - Perform 10 times, 4 front tire jumps and 4 back tire jumps equals one repetition



- Fast Feet
  - Standing in an athletic stance, weight on the balls of the feet, knees bent, quickly tap feet up and down, standing in place
  - Perform for 1 minute

- Line Jumps
  - This drill consists of multiple different jumps
  - 1. Jump back and forth sideways over the line with both feet
  - 2. Repeat, with only one foot, switch and repeat with the other
  - 3. Face the line, jump with two feet frontward and backward over the line
  - 4. Repeat, with only one foot, switch and repeat on the other
  - 5. Continue to face the line, start with both feet on the ground, step one foot over followed by the other, step one foot back behind the line followed by the other
  - Perform all of these drills in succession for 30 seconds each



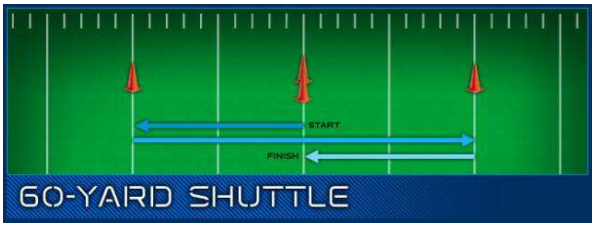
- Jumping jacks
  - Start with feet together, hands by the sides of the body
  - Jump, landing with feet apart and arms up in the air in an "X" shape
  - Return to starting position
  - Perform 20 repetitions

- Frog Jumps
  - These may be performed with or without a partner
  - Crouching like a frog, push up into the air, landing in the same initial position
  - If using a partner, use hands to push off the partner's back and jump over top of them, landing in a frog position
  - Perform 10 jumps

- Step Ups
  - Using a box, first step the right foot on top of the box, next lift the left foot to meet the right on top, bring the right foot back down, followed again by the left
  - Repeat 10 times, then 10 more leading with the left foot first

- Hop Scotch
  - Create a hopscotch board on the sidewalk with chalk, numbering the boxes up to 10 as shown in the display picture
  - Jump through the board using only one foot in each box, so that when only one box is in the a row the balance is all on one foot, but when there are two boxes next to each other both feet are on the ground
  - Once the number 10 box is reached, turn around and go back through the opposite way
  - The hopscotch board may be varied so that different jump patterns are created
  - Perform the exercise down and back 10 times

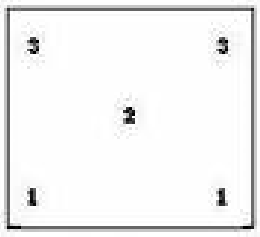
- Shuttles
  - This drill consists of multiple different paths



  - 1. Cones may be set up 60 yards apart, starting at one cone, run towards the other cone and then return back to the first cone, do this a total of 3 times there and back
  - 2. Cones may be set up 60 yards apart with one cone in the middle at the 30 yard line as shown below, starting at the middle cone, shuffle towards the right cone, turn and sprint all the way to the left most cone, then shuffle back to the beginning middle cone
  - Perform each of these shuttles once to conclude one set

- Somersaults
  - Start in a crouched position, lower head to ground, and roll the body over top the head, coming back to the crouched position
  - Perform 5 times

- Dot drills
  - There are multiple different variations of this drill
  - For all drills, follow the sequence of 3, 3, 2, 1, 1, 2, 3



  - 1. Follow the pattern, jumping with both feet together
  - 2. Follow the pattern, jumping on only one leg, repeat with the other leg
  - 3. Follow the pattern, placing one foot on each 3, then jumping both feet together on 2, then both feet back apart on each 1, turn around and jump both feet back together on two, and then back apart on each 3
  - Perform each drill 5 times to complete 1 set

- Agility Ladder
  - This drill contains multiple different moves down the ladder, each should be completed down and back as quickly as possible, staying up on the balls of the feet

  - 1. Run through the ladder, touching both feet in every box
  - 2. Run through the ladder, touching only one foot per box
  - 3. Shuffle sideways through the ladder, placing one foot in per box as shown in the display picture below
  - 4. With both feet together, jump forwards through the ladder
  - 5. With both feet together, jump sideways through the ladder, repeat facing the opposite direction
  - 5. Jump forwards through the ladder on one foot the whole way through, repeat using the other foot
  - 6. With both feet together, jump forwards skipping a box, then jump backwards one box, repeat jumping two boxes ahead and one box back
  - There are multiple other agility ladder moves available, which can be found online
  - Perform 6 moves of choice down and back 2 times each to complete one set

- Mountain Climbers

  - Place both hands on the ground directly under the shoulders, rest on the balls of the feet with legs straight out
  - Quickly bend one leg and bring the knee close to the chest, reaching forward with the toes of the foot as much as possibly, switch feet, straightening the first leg back out as the other bends in
  - Continue to switch feet as quickly as possible for a total of 30 seconds

- Heisman jump

  - Start balanced on one foot, the other leg bent with the knee angle diagonally up and pulled into the stomach area, place the arm on the side of the lifted knee straight out next to the ankle as shown in the display photo
  - Jump sideways, landing on the foot that was previously lifted, bringing the opposite leg up into the same position
  - Continue to jump side to side, holding the Heisman position for 2 seconds after each jump
  - Perform 20 repetitions

YELLOW GROUP

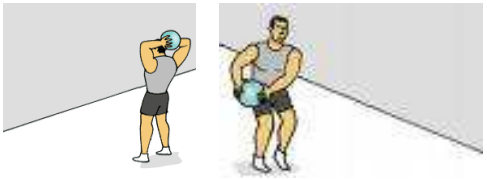
Choose 2-3 upper and 2-3 lower exercises for 2-3 workout sessions per week. Perform 3 sets of each move, with a rest period of 30 seconds to 2 minutes in-between.

UPPER BODY

- Medicine Ball Throw into the Ground
  - Start holding the ball above the head, bring arms down and slam the ball into the ground as hard as possible, catch the ball, and repeat
  - Perform 20 repetitions

- Medicine Ball Throw into the Air
  - Start with the ball at waist level, bring arms up over head and throw the ball straight up as high as possible, catch the ball, and repeat
  - Perform 20 repetitions

- Medicine Ball Wall Throws
  - This drill consists of multiple moves
  - 1. Starting with the ball above the head, throw the ball into the wall, catching it as it bounces back
  - 2. Starting with the ball at chest level, push the ball out again the wall, catching it as it returns back
  - 3. Standing sideways, throw the ball at hip height into the wall, catching it as it bounces back
  - Perform 20 repetitions of each throw to complete 1 set



- Prone Knee Fall
  - Kneeling, have a partner hold the back of the ankles
  - Slowly begin to fall forward, performing a pushup at the ground level in order to raise back to the beginning position
  - Perform 10 repetitions

LOWER BODY

- Star jumps
  - A variation of jumping jacks, begin with feet on the floor, hands by the sides of the body
  - Jump up into the air, bringing feet and arms apart into a star shape
  - Land back in the starting position
  - Perform 20 repetitions

- Leaps
  - Mark a space 3 feet long, start at one end of the space, pushing off one foot leap across the space, landing on the other side with the leading foot
  - Perform 20 repetitions

- Jump Rope
  - This drill utilizes a couple different variations
  - 1. Using a jump rope, jump with both feet over the rope as it swings around your body towards the ground
  - 2. Jump rope with only one foot, repeat with the other foot
  - 3. Jump rope backwards
  - Perform each drill 50-100 times to complete one set

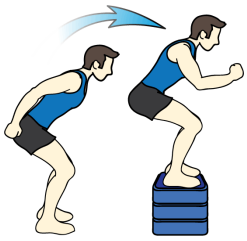
- Lunge jumps
  - Start in a lunge position, back leg bent with the toe on the ground and the knee resting just above the ground, front foot flat on the ground stepping out with the knee directly above the ankle, the body straight up with the shoulders and chest pulled back
  - Jump into the air, switching the feet, landing with the reverse foot forward
  - Perform 20 repetitions

- Squat jumps
  - Start in a squat position, feet shoulder width apart, toes pointing straight forward, knees bent at a 90 degree angle, chest and shoulders pulled back, fingers interlaced with the hands behind the head
  - From this position, push with the heels up into the air, straightening the legs, returning in the squat position landing on the ground
  - Perform 20 repetitions

- Jump w/ball between knees
  - Squeezing ball between the legs just above the knees, perform a squat jump
  - Perform 20 repetitions

- Shape jump from box onto ground
  - Begin standing on a box, jump up and off of the box, creating a shape with your body in the air, landing with both feet on the ground
  - Create a soft landing by controlling the contact with the ground, striving to land upon the balls of the feet
  - Perform 20 repetitions

- Jump onto box
  - Start standing in front of a box, feet shoulder width apart, knees slightly bent, arms slightly bent and down at the sides of the body
  - Push off the floor, jumping with two feet, landing on the box
  - After landing on the box, the exerciser may step back down off of the box and reposition for the next jump, or simply jump backwards off the box, landing in the starting position and continuing
  - Perform 20 repetitions



- Lateral box jump
  - Start standing sideways next to a box, feet shoulder width apart with knees slightly bent and arms down at the sides of the body
  - Push into the ground and jump sideways with both feet, landing on the box
  - Jump sideways back down off of the box
  - Perform 20 repetitions each side

- Hurdles
  - This drills consists of multiple moves
  - Set up 6 small hurdles in a straight row, 2 feet apart
  - 1. With both feet together, jump over each hurdle in succession
  - 2. With both feet together, jump over each hurdle sideways
  - 3. Jump over each hurdle with one foot, repeat with the other foot
  - Perform each drill 2 times to complete 1 set

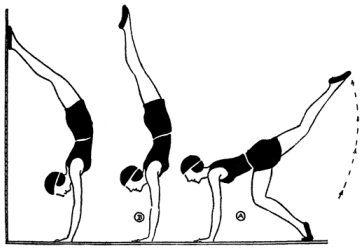
RED GROUP

Choose 2-3 upper and 2-3 lower exercises for 2-3 workout sessions per week. Perform 3 sets of each move, with a rest period of 30 seconds to 2 minutes in-between.

UPPER BODY

- Cart wheels
  - Following the path indicated by the display picture below, rotate the body by starting with the feet on the ground, then placing one hand next to the side of the body on the ground, turning the feet over the head as the other hand places down on the side of the first hand, then landing one foot at a time next to the sides of the hands
  - Perform 5 repetitions

Hand stands
  - Start a few feet away from a sturdy, predetermined wall, place the hands on the ground, shoulder width apart, keeping arms straight, kick the legs straight up over head, balance the feet against the wall, hold for 5 seconds
  - Perform 3 repetitions

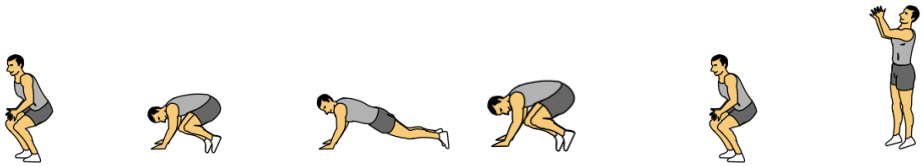


- Clapping Pushups
  - Start in a pushup position, either with knees or toes on the floor, arms bent with palms of hands flat on the floor, the body a few inches off of the ground in a straight line
  - Explode up, pushing off with the hands, clapping the hands together in the air, landing back in beginning pushup position
  - Perform 10 repetitions

LOWER BODY

- Tuck Jump
  - Start standing on the ground, feet shoulder width apart, jump up into the air, bringing the knees into the chest, landing back down in starting position
  - As the feet land, bend the knees and jump right into the next tuck
  - Perform 20 repetitions

- Burpees
  - Following the display sequence below, start standing, drop down into a crouching position, bring hands to the floor, kick both feet out backwards together, placing body in a pushup position, jump both feet back into the body, lift the upper body off the floor back into crouching position, jump into the air, lifting the hands above the head
  - Repeat 10 times to complete 1 set

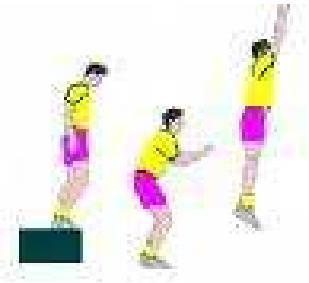


- Single Leg Box Jump
  - Perform the same as the box jump, using one leg, then repeating with other leg
  - Perform 10 repetitions each leg

- Single Leg Lateral Jump
  - Perform the same as the lateral jump, using one leg, then repeating with the other leg
  - Perform 10 repetitions each leg

- Jump sideways over box
  - Start standing sideways to the box, feet shoulder width apart, jump up with both feet, clearing the box and landing on the floor on the opposite side
  - Return by jumping back all the way to the other side of the box, never actually touching the box
  - Perform 10 repetitions, counting 1 as over and back

- Depth Jump 1
  - Start standing on the box, feet shoulder width apart, jump down off of the box, landing both feet on the floor and knees bent, without pausing, jump immediately off the ground into the air as high as possible, hands above the head
  - Perform 10 repetitions



- Depth Jump 2
  - Perform the same Depth Jump 1, only jumping onto a second box instead of straight up in the air

- Stair Jumps
  - There are several variations to this drill
  - 1. Run up a staircase, using every stair
  - 2. Jump up the staircase with both feet together, using every stair
  - 3. Jump up the staircase with both feet together, skipping every other stair
  - 4. Jump up the staircase with both feet together, moving at a diagonal so that the first jump lands on the left side of the stair, and the next jump lands on the right side of the next stair
  - Perform each drill 2 times to complete 1 set

PART IV

WORK OUT LOG

Use the spaces provided below to track your work and progress. Use a separate sheet for every exercise session. Write down any details to serve as reminders for future training sessions. For example, the date and time, plyometric moves chosen, how many times completed, and difficulty level perceived. For difficulty level, mark either E for easy, M for moderate, or H for hard. When an exercise becomes too easy, progress to a harder move next session.

Name: _____ Date: _____ Time: _____

Warm Up Move (If Performed):

Set #	Set 1	Set 2	Set 3
# of Repetitions			
Perceived Difficulty			

Warm Up Move (If Performed):

Set #	Set 1	Set 2	Set 3
# of Repetitions			
Perceived Difficulty			

Upper Body Move 1:

Set #	Set 1	Set 2	Set 3
# of Repetitions			
Perceived Difficulty			

Upper Body Move 2:

Set #	Set 1	Set 2	Set 3
# of Repetitions			
Perceived Difficulty			

Upper Body Move 3:

Set #	Set 1	Set 2	Set 3
# of Repetitions			
Perceived Difficulty			

Lower Body Move 1:

Set #	Set 1	Set 2	Set 3
# of Repetitions			
Perceived Difficulty			

Lower Body Move 2:

Set #	Set 1	Set 2	Set 3
# of Repetitions			
Perceived Difficulty			

Lower Body Move 3:

Set #	Set 1	Set 2	Set 3
# of Repetitions			
Perceived Difficulty			

READING LIST

Please refer to the following materials for further reading on the subject of plyometrics.

http://www.acsm.org/AM/Template.cfm?Section=Search%A7ion=20014&template=/CM/ContentDisplay.cfm&ContentFileID=310

http://www.donchu.com/articles/article7/

http://www.education.com/magazine/article/Fragile_Bones_Epidemic/

http://journals.lww.com/acsm-msse/Abstract/2000/06000/Effects_of_plyometric_jump_training_on_bone_mass.3.aspx

http://www.ncbi.nlm.nih.gov/pubmed/10862529

http://www.niams.nih.gov/Health_Info/Bone/Osteoporosis/osteoporosis_ff.asp

http://www.sport-fitness-advisor.com/plyometrics.html

http://www.ultimate-youth-basketball-guide.com/plyometrics.html