Warm-Up, Flexibility, and Cool-Down



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Introduction

The warm-up and cool-down portions of properly designed strength and conditioning programs are extremely important to include, but are often neglected as a means to save time. Failure to properly warm-up for physical activity not only creates a situation in which the athlete is exposed to a higher risk of injury, but also can hinder performance during such activity. Similarly, skipping a cool-down routine following physical activity can slow the athlete's recovery process. If the athlete fails to recover fully prior to the next workout session, he/she may be at an increased risk of overtraining and injury. Equally important for the athlete is the development of adequate and functional flexibility. As a further means of prevention against injury and a possible method of performance enhancement, flexibility should be included in most strength and conditioning programs (given the current physical status of the athlete). Warm-ups, flexibility activities, and cool-downs are all interrelated and should be integrated into every strength and conditioning program.

This manual will provide the reader with a physiological basis for including warm-up, flexibility, and cool-down activities, discuss the purpose of general warm-ups prior to strength and conditioning activities, outline the specifics regarding variations in flexibility programs, and provide sport specific examples of warm-up, flexibility, and cool-down routines.

Warm-Up

Physiological Basis for Warm-Up Activities

Research has indicated that properly warming up prior to physical activity can not only lower the risk of injury for the athlete, but also actually increase performance during the activity. The following list provides six basic physiological reasons why warming-up should be included prior to every workout (Foss and Keteyian).

1. During adequate warm-up activities there is a rise in body and muscle temperatures which causes an increase in muscle enzyme activity and the subsequent metabolic reactions associated with the energy systems (creatine-phosphate system, anaerobic/aerobic glycolysis, and aerobic respiration). This has a "priming" effect on the muscles, which better prepares them for further physical activity as well as increasing their speed and force of contraction.
2. Warming up increases blood flow and oxygen availability to muscle tissue. This prepares the muscles for activity and gives them the necessary oxygen and blood flow needed to perform.
3. Both increases in enzyme activity and oxygen levels (due in increased muscle temperature) have the combined effect of decreasing contraction and reflex time. (Fig. 1)
4. An increase in heart rate and muscle temperature during warm-up activity also promotes a rise in maximum oxygen uptake (VO2). (Fig. 2 and 3)
5. Increases in muscle temperature and blood flow helps to decrease blood lactate levels reducing muscular fatigue (important reason for cool-down activity) (Fig.4)
6. The higher the muscle temperature, the greater its flexibility. This guards against strains and other injuries (Baechle and Earle).

Figure 1 (Foss and Keteyian)

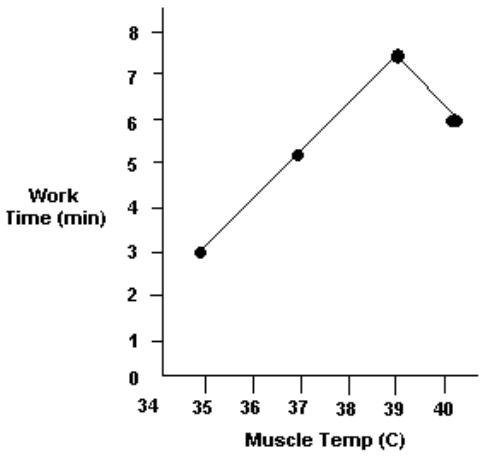


Figure 2 (Foss and Keteyian)

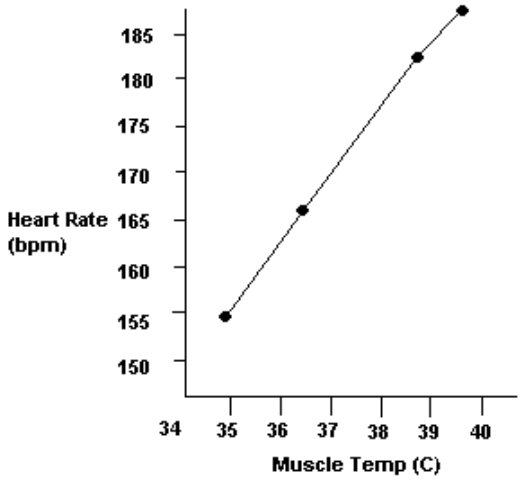


Figure 3 (Foss and Keteyian)

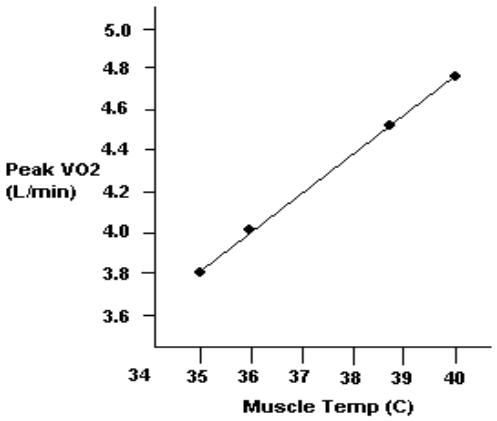
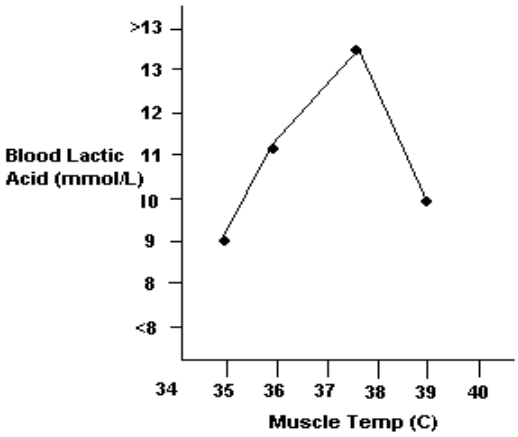


Figure 4 (Foss and Keteyian)



General Warm-Up

The general warm-up should always be done prior to any other physical activity. This is a very basic means of increasing body and muscle temperature for the purpose of injury prevention and increased performance. The actual activity during the warm-up is highly variable but usually involves low intensity aerobic activity for five to ten minutes. The goal of this activity is to accomplish all six physiological effects as listed above, as well as to begin perspiration (Baechle and Earle). The latter effect is desirable because it shows whether or not an adequate rise in body and muscle temperature has been achieved. It also provides a psychological effect that lets the athlete know that he/she is ready for an increase in exercise intensity.

Some examples of general warm-up routines include slow jogging and stationary bicycle riding. Others include jump rope, stair climbing, and elliptical cycle riding. All of these activities must be done at an intensity to ensure an increase in heart rate, body/muscle temperature, and perspiration.

Specific Warm-Up

The specific warm-up follows the general warm-up and usually focuses on sport or lift specific movements (Baechle and Earle). This warm-up should last for a period of eight to twelve minutes and directly precedes the actual workout or sport activity. Specific warm-ups are as variable as the sports and lifts they prepare the athlete for. For example, if an athlete is preparing for a bench press workout, he/she may perform one to two sets of bench press at a lighter weight before building up to higher intensities (Thomas). In a sport such as football, a specific warm-up for a quarterback would be to throw a football in a relatively low intensity manner prior to practice or a game.

Functional Warm-Up

The functional warm-up incorporates aspects of both the general warm-up and specific warm-up. It can be done for varying amounts of time, but usually for at least five minutes and no more than twelve minutes. The target of the functional warm-up is not only the specific muscle and joints involved in the proceeding activity, but the stabilizer and core musculature as well (Thomas). The implements used in functional warm-up routines are as variable as the activities they help prepare the athlete for. Some warm-ups, such as the dynamic flexibility warm-up, involve little or no implements. Other warm-ups (such as hurdle walks, physioball activities, and agility ladder drills), involve the use of basic equipment.

Warming-up with functional drills increases core and muscle temperature, while working on the athlete's balance and coordination for the sport or lift he/she is preparing for. In this way, the functional activities accomplish both general and specific warm-up goals while also improving the athlete's proprioception (Thomas). Additionally, the athlete's stabilizer muscles are activated and warmed-up which may decrease the risk of injury during the following sport activity or weight training session.

The Core

The core musculature refers to the abdominal, oblique, lower back, and hip muscles that serve as both stabilizer and initiator of all human movement. All of these muscles and their surrounding connective tissue serve to support the spine and the pelvic girdle (Santana). As critical as the core is for movement, it is an often overlooked and heavily injured portion of the human physique. When targeting the core for training, such as with abdominal, back, hip, and balance exercise (which incorporates core muscle activity in order to stabilize the body), it is important to first warm-up the area properly. For the core, simple stretches are not enough, but still should be done. Many of the following functional warm-up activities help target the core because they are done in sport-specific, standing positions that require core activity to help stabilize the movement.

Training the Core

The core can be trained before, during, or after the workout or sport activity. When it is trained depends on the goal of the workout itself and the current status of the individual athlete's core strength. If the core is targeted prior to the workout, and is partitioned into the warm-up, the goal of the activity is to pre-exhaust the core musculature in order to further enhance the balance and stability training of the workout (as the athlete will be less stable). This is a keystone of Stability Limited Training (SLT) which specializes in core, balance, and stability training (Santana). Should the core be trained during the workout, the athlete will experience a superior total body workout and will be thoroughly fatigued by the end of the session when stability is most important. This also serves to enhance the core, balance, and stability attributes of the athlete. Finally, if the core is targeted in the post-workout cool-down phase, the athlete will be able to remain fully stable for the workout (perform at peak efficiency) and then exhaust the core afterwards. In this type of workout, the athlete should work the core throughout the training session (by means of functional, ground based training) and then "finish off" those muscles in the end.

When To Train The Core

- Prior To Workout – To warm-up the body for training
- During The Workout – For all-around total body training
- After The Workout – To work the core as part of a cool-down routine

Areas To Target

There are four basic areas to target when prescribing core training exercises. These include the abdominals, obliques, back, and hip musculature. It is best to include one or two exercises that work each of these four areas in every core routine.

- Abdominals
- Obliques
- Back
- Hip

Specific Spinal Movements Used To Train The Core

The following spinal movements are utilized to train the core muscles. As mentioned previously, it is best to include at least one or two exercises that use these movements.

- Flexion (abdominals and hip)
- Extension (back and hip)
- Lateral Flexion (back and obliques)
- Rotation/Diagonal Rotation (obliques, back, and hip)
- Stabilization (isometric) (total core musculature)

Flexion Exercises – No Implements

Choose any one or two

- Flat-foot crunch
- Flat-foot sit-up
- Straight-leg (on floor) crunch
- Straight-leg (held up off the floor) crunch
- Feet-up crunch
- Reverse crunch
- V-up
- Alternating hand-toe crunch
- Three tier crunch
- Decline crunch or sit-up
- Hip thrust
- Regular or alternating jack knife
- Leg raises or lowers

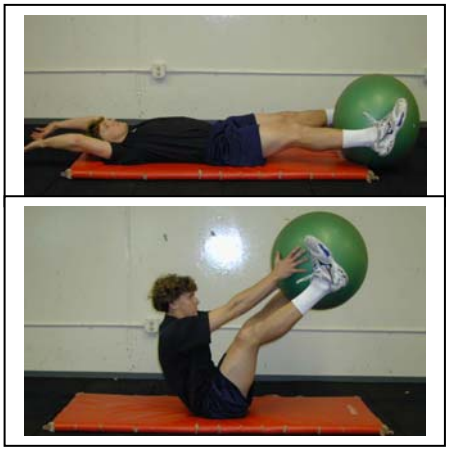
Flat-Foot Sit-Up

Flexion Exercises – Implements

Choose any one or two to substitute for non-implement exercises

- Plate or medicine ball (MB) crunch
- Plate or MB sit-up
- Plate or MB decline crunch or sit-up
- V-up with physioball (PB) exchange
- Extended crunch on PB
- Decline MB sit-up toss (to partner or on wall)
- Hanging knee or leg raise
- Knee to chest using abdominal wheel
- Wood chop (up and down) using MB
- Reverse crunch with PB or MB between legs
- Hip thrust with PB or MB between legs

V-up With PB Exchange



Extension Exercises – No Implements

Choose any one or two

- Regular and alternating supermans
- Bird-dogs
- Hyperextensions (with or without twist)
- Reverse hyperextensions (straight-leg or circling legs in/out)

Hyperextensions

Extension Exercises – Implements

Choose any one or two to substitute for non-implement exercises

- Supermans or alternating supermans on a BOSU® Trainer
- Hyperextensions with MB or plate (with or without twist)
- Reverse hyperextensions with MB between legs or manual resistance
- Hyperextensions or reverse hyperextensions on PB
- One-leg hip extension on PB
- MB RDL toss (wall or partner)
- MB granny toss

MB Granny Toss

Lateral Extension Exercises – No Implements

Choose any one or two

- Overhead obliques
- Lying oblique crunch
- Off-bench oblique (with or without twist)

Off-Bench Obliques

Lateral Extension Exercises – Implements

Choose any one or two to substitute for non-implement exercises

- Overhead obliques with plate or MB
- Lying oblique plate or MB crunch
- Off-bench oblique with plate or MB (with or without twist)
- Oblique crunch on PB

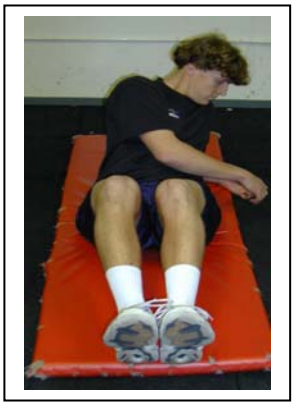
Overhead Obliques With MB

Rotation/Diagonal Rotation Exercises – No Implements

Choose one or two

- Russian twist (regular or decline)
- Lying 90° trunk twist
- Bicycle crunch

Regular Russian Twist



Rotation/Diagonal Rotation Exercises – Implements

Choose one or two to substitute for non-implement exercises

- Russian twist with plate or MB (regular or decline)
- Lying MB 90° trunk twist
- Hanging knee or leg raise with twist
- MB Rocky twist (half or full)
- MB side throws (wall or with partner)
- Shou-Hip twists on Dyna Disks®
- Extended crunch with twist
- Cross-over oblique crunch
- MB diagonal wood chop

MB Side Throw

Stabilization Exercises – No Implements

Choose one or two

- Elbow bridge on floor (one or two leg)
- Push-up bridge on floor (one or two leg)
- Iron cross
- Handstand bridge
- V-sit

Iron Cross

Stabilization Exercises - Implements

Choose one or two to substitute for non-implement exercises

- Elbow bridge on PB (one or two leg)
- Push-up bridge on PB (one or two leg)
- Supine bridge on PB (one or two leg)
- V-sit on BOSU
- Isometric off bench oblique on PB
- Squat or RDL on BOSU®, Dyna Disks® or other SLT device

Supine Bridge on PB

Sample Routine

1. Plate crunch
2. Russian twist
3. Leg raises
4. Supermans
5. Elbow bridge

Functional Warm-Up Activities

Dynamic Flexibility Warm-Up (No Implements)

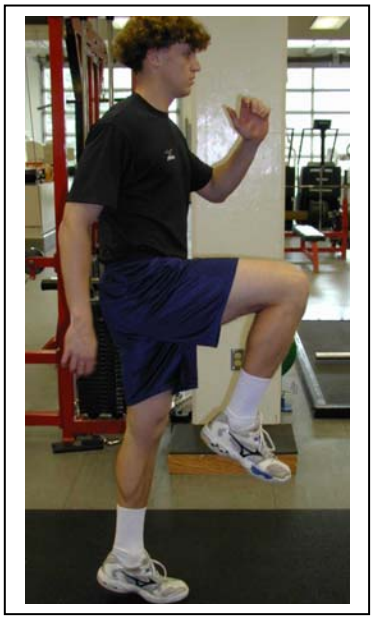
The most basic form of specific warm-up, and one that does not involve implements, is the dynamic flexibility warm-up. These activities can either be general (working for most or all athletes) or very specific (i.e. volleyball dynamic warm-up).

Dynamic Flexibility Variations (Healy, Bellofatto, Brand)

Low Intensity

- Easy jog
- Low intensity skips
- Low intensity lateral shuffle
- Straight-leg jog
- Hip Swings (4-way)
- Arm Circles
- Push-ups (slow and controlled)
- Carioca
- Ankling (lateral and forward)
- Low shuffle

Low Intensity Skip



Lunging and Stretching

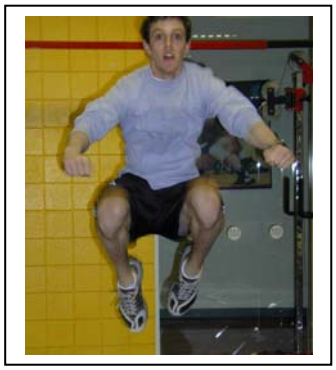
- Lunge walks (with twist, or shoulder stretch)
- Backward lunge walks (with or without reach)
- Inch worm
- High knee walk with ankle (hug knee to chest)
- Walking toe touches
- One-leg RDL with ankle
- MB Sumo squats and regular squats (gut-wrench the ball)
- Sumo Squats
- Low walk
- Reverse lunge cross behind
- Cross-over reach

Lunge Walk

High Intensity

- Power skips
- High intensity lateral shuffle (incorporating height)
- High knees
- Butt kicks
- Backward running
- Bounding
- Carioca with high knee cross-over
- Squat jumps
- Tuck jumps

Tuck Jump



Band Walk Warm-Up

Walking with elastic bands attached to the legs provides resistance for the hip joint and the surrounding musculature. It is an effective method of strengthening and/or warming up a region of the body that often is overlooked. The drills themselves are simple in nature but the athlete must use strict form in order to get the most out of the exercises. The bands provide a resistance to help with prehabilitation and rehabilitation for the thigh and knee.

Walking Variations

- Low stance forward
- Low stance lateral
- Low stance backward

Low Stance Forward

Jump Rope Warm-Up

Rope jumping provides an excellent specific warm-up for agility and speed activity with minimal use of implements. The athlete must be quick and accurate with his/her foot placement and can progress from the simplest of jump rope drills to the very complex. In the case where rope jumping is used as a warm-up for further agility and speed work, simple drills are all that may be needed to accomplish the goal of the warm-up. While the general warm-up, such as on a stationary bicycle, may provide a means to increase body and muscle temperature, the specific warm-up with a jump rope helps to warm-up the neuromuscular system for the intensity of the workout or sport.

Foot Contact Variations

- Two feet forward
- One foot forward
- Two feet running
- Two feet side to side
- One foot side to side

Rope Direction Variation

- Forward
- Backward
- Cross-over
- Double jumps

Sample Jump Rope Routine

1. 50 revolutions forward
2. 50 revolutions side to side
3. 50 revolutions running
4. 30 revolutions each foot
5. 30 revolutions backward
6. 30 double jumps

Jump Rope

Dot Drill Warm-Up

The dot drill provides a high intensity neuromuscular warm-up that provides ample preparation for high intensity/explosive sports and lifts. It is also an excellent means to work on the athlete's balance, coordination, speed, agility, and quickness. Coaches should cycle the programming for the athletes properly and begin with simple, two-foot drills and then move onto more complex (and intense), one-foot drills. These drills can be performed for specific time periods or for repetitions.

Contact Variations

- Two feet
- One foot

Movement Variations

- Triangle
- Four corners
- Figure eight
- Z
- X (twist or regular)

X Drill

Agility Ladder Warm-Up

The agility ladder is another simple implement used to perform specific drills to help warm-up the athletes neuromuscular system in preparation for further increases in intensity during the workout or sport activity. The movements performed during agility drills on the ladder help prepare the body to move in an explosive, yet accurate manner (such as when performing explosive lifts or fast sport movements) (Ebel). It is best to try to match the agility ladder drills with whatever activities are planned for the proceeding workout or sport. They are most effective when performed prior to lower body workouts or explosive training. The drills themselves range from very simple, footwork improvement routines to explosive bounding activities. It is best to begin with the easier drills and progress to the higher intensity movements (Ebel).

Agility Ladder Variations (Bellofatto, Healy, Ebel)

Speed/Foot Work Drills

- One foot run through (fig. 1)
- Two foot run through (fig. 2)
- Lateral double step (fig. 3)
- Cross-over run through (fig. 4)
- Icky shuffle (fig. 5)
- DB drill (fig. 6)

Speed/Hip Mobility Drills

- Icky shuffle with cross-over (fig. 1)
- Scissors kick (fig. 2)
- Hip twist (fig. 3)
- Karaoke (fig. 4)
- Split twist (fig. 5)
- Wondering split twist (fig. 6)
- Ricky Martin – 1 foot in each box (fig. 7)
- Ricky Martin – 2 feet in each box (fig. 8)

Bounding Drills

- Forward line hops (fig. 1)
- Alpine ski (fig. 2)
- Lateral alpine ski (fig. 3)
- 4-corner bunny hop (fig. 4)
- Two hops forward, one back (fig. 5)
- Lateral line hop (fig. 6)
- Alternating split hops (fig. 7)
- Single-leg forward hops (fig. 8)
- Single-leg lateral line hops (fig. 9)
- Single-leg alpine ski (fig. 10)
- Speed skater (small step, cross over, lunge) (fig. 11)

Karaoke Drill

Cone Drill Warm-Up

Similar to the agility ladder, cone drills are also an exceptional way to warm-up the neuromuscular system. The drills themselves are often of the "shuttle" variety, with plenty of misdirection and fast changes in momentum. This provides a safe yet challenging means to warm-up various tendons, ligaments, and joints in the legs. It is most effectively used prior to speed, plyometric, and agility workouts. The drills themselves can be done for a specific number of times (3 times through) or for a certain time period (3 sets of 30 seconds). For the purpose of warming up only, choose one or two of the easier drills and progress to the more difficult movements as the workout moves on.

Cone Drill Variations (Healy)

- Short shuttle
- T-drill
- 3-cone
- 5-cone star
- Zig zag drill
- 10-yard square drill
- V-cone drill
- W-drill
- Zig zag circle drill
- 3-yard square
- 5-cone maze drill
- 4-Cone Shuttle (forward 5-yd, back 5yd into defensive position)

Short Shuttle Cone Drill

Micro Hurdle Warm-Up

Micro Hurdles provide a barrier small enough for the athlete to quickly jump over (like a ladder), but high enough to make the jump a challenge and create a more explosive movement. These drills provide an adequate neuromuscular challenge (for the purpose of warming up), and an effective means to warm-up and stretch joint connective tissue. All of the drills can either be performed for a given number of times or for a specific time period.

Contact Variations

- Two feet hops
- One foot hops
- Running
- High knees
- Jumping

Examples of Micro Hurdle Drill Exercises (Healy and Bellofatto)

- One foot in the hole
- Two feet in the hole
- Zig zag
- Hops
- Sideways
- Hurdle races
- Diagonal hurdle drill
- Diagonal hurdle hop
- Foot plant drills
- Hurdle four square
- Hops with sprint over hurdles

One Foot In The Hole Drill

High Hurdle Warm-Up

Using the high hurdles for warm-up drills can provide ample stretching and flexibility work for the hip joint. It can also help to increase the range of motion in the hip. Once again, it is important to begin with easier drills and progress to more difficult activities. The instructor is expected to ensure that the athletes maintain their focus, proper posture, and proper body alignment. The high hurdles can also be used to jump over as a more intense warm-up for the neuromuscular system. Often, high hurdle walk drills precede high hurdle hops in order to ensure that the athlete is properly conditioned for these more intense activities. The athletes should concentrate on landing properly and minimizing ground contact.

High Hurdle Movement Variations

- Walking
- Jumping
- Kicking
- Walking under
- Shooting under

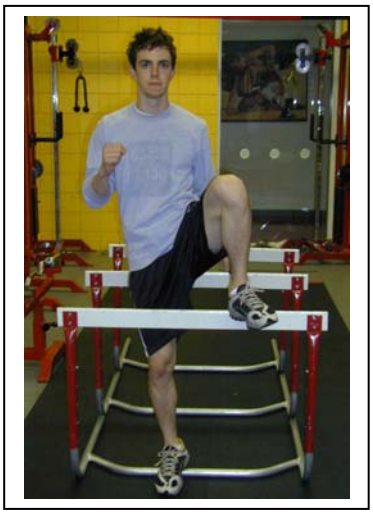
Contact Variations

- Forward one or two feet in each gap
- Sideways one or two feet in each gap
- Backward one or two feet in each gap

Points For The Athletes To Remember

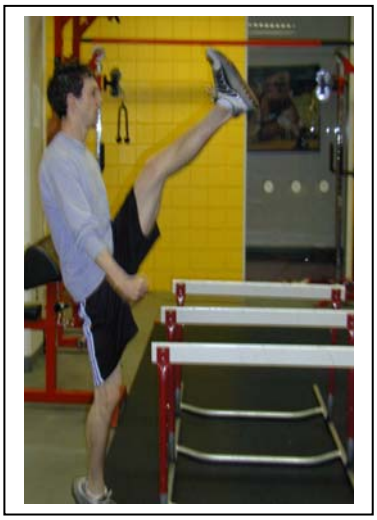
- Maintain focus
- Use proper body posture
- Use full triple extension of ankle, knee, and hip
- Land properly and balanced

Forward One Foot In Each Gap



Sideways One Foot In Each Gap

Lateral Kicks Over Hurdle



Medicine Ball Warm-Up

The medicine ball provides a versatile form of resistance that can be held, swung, or thrown for purpose of warm-up activity. The exercises can range from simple and low intensity holds (such as squatting with the ball) and swings to explosive throws and tosses. The medicine ball can be used to target nearly all parts of the body, but is especially effective at warming-up the core musculature (abdominal, back, and hip).

Medicine Ball Training Zone Variations

Core

- Up/down wood chops
- Diagonal wood chops
- One leg wood chops
- Side throws
- Side twists (Rocky twists or horizontal swings)
- Granny toss
- RDL toss
- Shovel tosses (standing or kneeling)

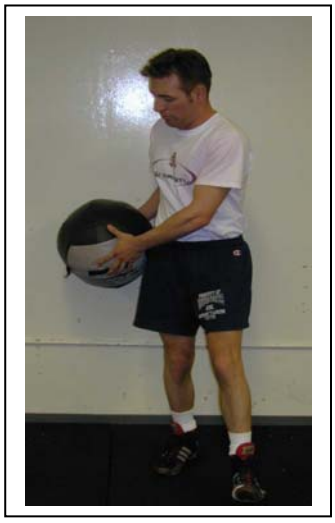
Upper Body

- Chest pass
- Kneeling chest pass onto hands
- Overhead pass
- Push-ups on or onto MB
- Punches

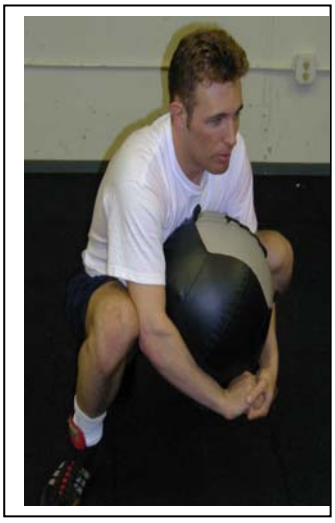
Lower Body

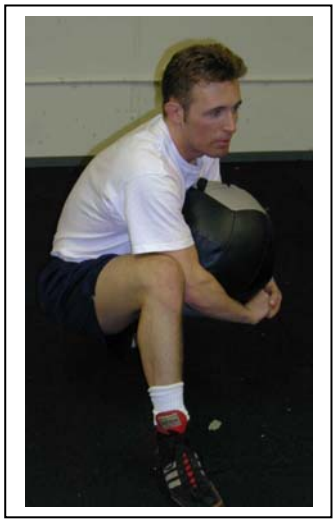
- Low walks
- Squats
- Squat jumps (regular and sumo style)

MB One-Leg Wood Chop



MB Low Walk





Low Intensity Plyometric Warm-Up

Low intensity plyometric exercises provide the athlete with preparatory movements for more explosive and higher impact activities that follow. Many of these exercises mimic sport or lift movements and are therefor highly specific. These activities also closely resemble dynamic flexibility movements and produce similar results. It is best to start easy with simple drills and progress to more complex and intense motions.

Low Intensity Plyometric Exercises

- Marching
- Jogging (ankling, straight leg jogging, butt kicks)
- Skipping
- Shuttles
- Shuffles
- Striders
- Bounding
- Single-response box jumps
- Valley jumps
- Pogo hops

Box Jumps

Flexibility

Introduction

Flexibility in the muscles and joints is an important part of many sport movements. If an athlete can achieve an optimal amount of flexibility, performance may be enhanced due to an increased range of motion about a joint and a decreased risk of musculoskeletal injury (Baechle and Earle). There are different types of flexibility and several ways to achieve greater ranges of motion about joints and their surrounding tissues. Some professionals also believe that more flexibility in some joints is not as necessarily desirable as improvements in stability. These issues will be discussed in the following.

Types of Flexibility and Structural Limitations

There are essentially two forms of flexibility: static and dynamic (Foss and Keteyian). Static flexibility is the range of motion about a joint and it's encompassing muscle and connective tissue during a passive movement. Dynamic flexibility is the available range of motion about a joint and its surrounding tissues during active muscle movements (Baechle and Earl).

The body possesses several inherent structural limits to flexibility. These include bone, muscle (bulk), connective tissue (elasticity and plasticity), and skin (Foss and Keteyian). To a certain extent, an athlete cannot achieve a level of flexibility beyond what is limited by these factors, or if he/she does, may run the risk of destabilizing joints and increasing the risk of injury during activity. In addition to the structural limits to flexibility, there are also other factors. The structure of the joint itself often dictates what kind of movement and how much motion is allowed. For example, the ball-and-socket joint of the shoulder has the least amount of structural limitation (such as bone) and has a far greater range of motion than the hinge joint of the knee. Another factor is the age and sex of the athlete. Young and female athletes generally possess greater flexibility than both older participants and male athletes. The final factor affecting flexibility, and one of the most important, is the activity level of the participant. A sedentary person will have far less flexibility than even the most average exercise participant (Baechle and Earle) will.

Stability vs. Flexibility

Some of the body's joints are structurally weak, and one of the most obvious is the shoulder. While the shoulder has the greatest range of motion of any of the body's joints, it also has a high propensity to become injured. The glenoid fossa of the scapula (the "socket") is shallow, so the shoulder joint relies on the surrounding connective tissue and musculature to provide it with stability. Should the encompassing structures become too flexible to the point that they are relatively flaccid, there will be a greater risk of ligament sprains, muscle strains, and even shoulder dislocation (Foss and Keteyian). The athlete and training staff must create an optimal balance of flexibility and stability at the shoulder, and other joints such as the knee and hip. It is know widely regarded and accepted that a specific degree of flexibility is preventative of injury, but an excessive amount of flexibility is prone to injury (especially in contact sports) (Foss and Keteyian).

Stretching

Stretching is a means to increase range of motion about a joint by taking advantage of the plasticity properties of connective tissue. Plasticity in connective tissues is defined as the tendency of the structure to assume a new and greater length when stretched (Baechle and Earle). Stretching exercises target connective tissues, such as ligaments, tendons, fascial sheaths, and joint capsules and produce increases in their length and range of motion. Stretching is usually performed prior to sport or training activity, but after a general warm-up (as increases in muscle and body temperature allow for greater flexibility in the connective tissues). These exercises are also done following the sport or workout during the cool-down phase as a means to further enhance range of motion (Foss and Keteyian).

Proprioceptors and Stretching

Proprioceptors are organs and tissues that provide the central nervous system with kinesthetic information concerning body position and muscle stretch/tension. There are two main types of proprioceptors: muscle spindles and the Golgi Tendon Organ (Marieb). The muscle spindles, also known as the intrafusal fibers, monitor and report changes in muscle length. Whenever a rapid stretch of muscle tissue occurs, the muscle spindles are stimulated to send a sensory signal to the spine, which in turn stimulates a motor neuron to contract the muscle. This is known as the stretch reflex (Marieb). Stimulation of the muscle spindles is often undesirable during stretching as it impairs range of motion due to the activation of the muscle itself. When the muscle is stretched without activating the stretch reflex, the muscle is relaxed and a greater range of motion is achieved. The second type of proprioceptor is the Golgi Tendon Organ (GTO). This receptor is located near the musculotendinous junction and it is sensitive to increases in muscle tension. Rapid increases in muscle tension stimulates the GTO, which then causes the muscle to relax (Marieb).

Autogenic and Reciprocal Inhibition

Relaxation that occurs in the same muscle experiencing an increase in tension (activated by the stimulated GTO) is known as autogenic inhibition. This reflexive inhibition of muscle action is desirable when attempting to stretch and is especially important to achieve when performing Proprioceptive Neuromuscular Facilitation (PNF) stretches. Reciprocal inhibition is the relaxation of the muscle opposite the muscle experiencing increased tension (or the antagonist relaxes as the agonist undergoes tension). This type of inhibition is also a part of PNF stretching, which will be described in its entirety later (Baechle and Earle).

Types of Stretching

There are two basic categories into which the types of stretching fall. The first is active stretching, which involves the athlete providing the force for the stretching movement. The other category is passive stretching, in which the force for the stretch is supplied by a partner or stretching apparatus (Baechle and Earle).

Static Stretch

The static stretch involves slow and constant stretching force with the end position (position of greatest range of motion) held for 20 to 30 seconds (Baechle and Earle). The stretch can either be active (i.e. the athlete puts his/her body into the position) or passive (use of a partner or device). Static stretching must be performed in a slow and controlled manner so as not to stimulate the muscle spindles and the stretch reflex. The muscle is relaxed and able to undergo a stretch in order to increase its range of motion. Static stretching has been shown, through research, to be an effective way to increase flexibility and range of motion (Brodowicz, Welsh, and Wallis). This type of stretching is preferentially performed after a workout during the cool-down period.

Ballistic Stretch

Ballistic stretching involves active muscular effort on the part of the athlete. There are usually “bouncing” type movements in which an end position of a stretch is found followed by the athlete bouncing to achieve a further position (Baechle and Earle). This type of stretch activates the muscle spindles and the stretch reflex and does not allow for the greatest range of motion. There is also an increased risk of injury due to the concurrent contraction and stretch of the muscle tissue (Baechle and Earle). Ballistic stretching is therefor not recommended as the first stretch done during the warm-up period but may be effective for some athletes (such as runners) after their general warm-up and stretch but before their workout or competition.

Dynamic Stretch

This type of stretching involves active movements like ballistic stretching, but slow and controlled enough not to illicit the stretch reflex response. The movements are usually sport specific and do not involve bouncing movements (Baechle and Earle). Dynamic stretching falls under the functional warm-up category as it helps to increase functional and sport-specific flexibility.

Proprioceptive Neuromuscular Facilitation (PNF) Stretch

PNF stretching was originally designed to assist with athlete's neuromuscular rehabilitation following an injury. This type of stretching is considered superior to the others because it takes advantage of muscular inhibition (autogenic and reciprocal). PNF stretching may be impractical for many situations because it requires a partner with knowledge of how to properly perform the exercises (Baechle and Earle). There are three basic types of PNF stretches: Hold-Relax, Contract-Relax, and Hold-Relax with Agonist Contraction.

PNF Hold-Relax Stretch for the Hamstrings (Baechle and Earle)

1. A passive pre-stretch is held by the athlete at the point of mild discomfort for 10 seconds
2. The partner then applies a hip flexion force and the athlete is instructed to hold the leg isometrically and not let the partner move the leg. The athlete resists the movement for 6 seconds
3. The athlete then relaxes as the partner stretches the leg (without help from the athlete) in a position further than the first pre-stretch for 30 seconds
4. The stretch is further the second time due to **autogenic inhibition**

PNF Contract-Relax Stretch for the Hamstrings (Baechle and Earle)

1. Passive stretch is held by the athlete at the point of mild discomfort for 10 seconds
2. The athlete then extends the hip against a hip flexion resistance force applied by the partner so that a concentric muscle action occurs through the full range of motion
3. The athlete then relaxes and the partner stretches the leg in a position further from the first pre-stretch for 30 seconds
4. The stretch is further the second time due to **autogenic inhibition**

PNF Hold-Relax with Agonist Contraction (Most Effective) (Baechle and Earle)

1. Passive stretch is held by the athlete at the point of mild discomfort for 10 seconds
2. The partner then applies a hip flexion force and the athlete is instructed to hold the leg isometrically and not let the partner move the leg. The athlete resists the movement for 6 seconds
3. The athlete then contracts his/her hip flexors to aid the partner's hip flexion force during the second stretch and holds it for 30 seconds
4. The stretch is further the second time due to both **autogenic inhibition** and **reciprocal inhibition**

Cool-Down

Physiological Basis for Cool-Down Activities

There are two basic reasons why athletes should include cool-down exercises after workouts and practice/competitions. The first reason involves blood chemistry. Lactic acid levels in both blood and muscle tissue decrease more rapidly during low intensity exercise-recovery than during rest-recovery (Ahmaidi). Studies have shown that a high level of lactic acid in both blood and muscle creates high levels of fatigue and a decrease in athletic performance. Active rest following an intense training session can help to decrease fatigue and enhance recovery times by aiding lactic acid clearance from muscle tissue and blood (Ahmaidi). The second reason involves one of the primary physiological functions of muscle tissue itself. During active recovery, the "muscle pump" stays active to prevent the pooling of blood in the extremities (particularly the legs) (Foss and Keteyian). The "muscle pump" refers to the alternating contraction and relaxation of skeletal muscle that creates a milking action on the veins to aid with venous return. By preventing the pooling of blood in the extremities, active rest helps to reduce the onset of delayed muscle soreness (DOMS) or the risk of fainting or dizzy spells (Foss and Keteyian).

Cool-Down Exercise Selection

Cool-down routines tend to be less structured and less specific than warm-up routines, but are no less important. Their lack of strict specificity makes cool-down routines easier to create and usually easier to perform. Coaches and athletes need to remember not to make these activities too intense (as they are supposed to prepare the body for relaxation in post-workout time), and not too complex as the workout itself. The athlete may be fatigued enough already where complex activities may not be done with proper form and therefor may run the risk of suffering an injury, which destroys the entire reason for a cool-down.

Static Stretching

It is generally regarded that static stretching occur during cool-down activity. Static stretching is most effective at creating increases in ranges in motion when the muscles and the associating connective tissue structures are warm and at their most plastic state (Foss and Keteyian). Stretches should be done for all of the major extremities utilized in the sport or workout and for the core stabilizers as well. As described earlier, these stretches should be performed in a slow and controlled manner for 20 to 30 seconds (Baechle and Earle).

PNF Stretching

Similar to static stretching, PNF stretching is at its most effective when following a workout during cool-down activity (Baechle and Earle). As superior as PNF stretching is, however, it requires a partner with knowledge on how to properly perform the exercises in order for the athlete to get the most out of them.

Dynamic Stretching

Dynamic stretching fits best into cool-down routines as it incorporates both active movement and stretching. This combined action has the effect of successfully continuing the muscle pump (to reduce the risk of DOMS and fainting), clearing lactic acid from blood and muscle tissue, and increasing ranges of motion (Baechle and Earle).

Ballistic Stretching

Ballistic stretching, as discussed previously, involves active muscle movements that stimulate the muscle spindles (and the subsequent stretch reflex). Since there is an increased risk of injury with this type of stretching (and it is more intense), it is best to avoid it when performing cool-down activities.

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