Musculoskeletal Strength and Conditioning

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Strength and Conditioning

- Basic Principles
- Cardiovascular
- Muscular development
- Flexibility
- Athletic Development
- Injury prevention
- Pitfalls
Basic Principles

• Physical conditioning helps to improve athletic performance and may decrease some risk of injury
• Strength represents only a small portion of athletic success
  – Strength, speed, agility, cardiovascular, flexibility and sport specific skill all contribute
• Sport specific training based on individual demands is most effective
• Balance of adequate stress and recovery are necessary for success
  – Periodization
  – Load tolerance is very individual
Basic Principles

• Overload/Overreaching
  – short-term overload training that is design to produces the necessary adaptations to improve strength and fitness
    • *Functional overreaching* occurs when such a training load is then paired with an appropriate recovery period, and the athlete fully recovers and ideally is able to perform better.
    • *Non-functional overreaching* occurs when the recovery is inappropriate for the training load such that complete recovery cannot occur.

• Overtraining
  – Complex syndrome defined as
    • a physical, behavioral, and emotional condition that occurs when the volume and intensity of an individual's exercise exceeds their recovery capacity
  – Thought to occur from prolonged periods of non-functional overreaching

• Periodization
  – Plan for training cycles ensuring adequate stress and recovery
    – Linear
      • ↓ Volume with ↑ intensity as athletes progresses to competition
      • Best for when a single performance peak is needed (ie Olympic weightlifting)
    – Non-linear
      • Varies training and volume based on total loads including games
      • Best for multi-game season or multi-sport athletes
Cardiovascular Training

• Aerobic
  – Aerobic capacity – (VO2 max)
    • the maximum amount of oxygen the body can use during a specified period, usually during intense exercise
      – Can be measured or estimated
    • Mainly genetic but can be trained
      – Average 17% but both low and high responders
    • Require intense exercise for weeks to improve
    • Loss ≈ 1% per year
    • Women lower aerobic capacity (average 10%)
Cardiovascular Training

• Aerobic
  – Lactate Threshold
    • Lactate is a byproduct of muscle work (glycolysis)
      – Accumulates with high intensity work
    • Used as muscle fuel as well
    • Easy to measure by exercise testing
      – Directly by blood levels
      – Estimated by HR and/or respiratory rate
    • Indicates ability to maintain % of VO2 max
    • Can be trained
      – Training just below threshold
Cardiovascular Training

• Aerobic
  • Training 3-5 times per week optimizes improvement
  • Improvement varies with fitness level
  • Must be adjusted every few weeks to continue to make improvements
  • Intensity involves both work load and duration
    – Both must be modified to improve and ensure recovery
Cardiovascular Training

• Anaerobic
  • Short maximal intensity efforts
    – Working above aerobic threshold
  • High energy phosphate and anaerobic glycolysis
  • Can only be maintained for short intervals
  • Component of many sporting events but contribution varies
    – Training time should be based on physiological need for the competitive sport
Muscular Development

• Muscle Physiology
  – 2 main responses to resistance training
    • Neuromuscular coordination
      – Initial adaptation
      – Muscle function more efficiently therefore can increase force generation
    • Hypertrophy
      – Muscle fibers increase cross sectional area
        » Takes in general 4-6 weeks to make measurable changes
      – Can be reversed with deconditioning
Muscle Physiology

- **Type 1 Fibers**
  - Slow twitch
  - High endurance

- **Type 2 Fibers**
  - Fast twitch
  - Intermediate to low endurance

- **human muscle is made up of a mixture of type I and type II fibers; muscle fiber type depends not on any intrinsic feature of the fiber itself but on the motor neuron supplying that particular fiber**

**Sporting activity requires a combination of both types**
Muscular Development

• Resistance Training
  – Improves muscle and bone strength
  – In combination with other training can improve performance
    • Important to note: ↑strength ≠ ↑ performance necessarily
  – Some training may decrease injury risk
Muscular Development

• Resistance Training
  – Important to define goals
    • Overall fitness
    • Improve performance
    • Appearance
  – Functional strength training
    • Increasing strength in a sport and/or movement specific pattern
    • Generally involves whole body lifts with coordination of muscle actions
    • Has potential to improve performance
Resistance Training

• How much, how many how often?
  – How much
    • 30-50% of 1 rep max (RM) for explosive power
    • 70-100% of 1 RM for muscle size increase
    • 1 RM can be directly measured or estimated
      – 1RM = 0.033(reps)x (repetition weight) + repetition weight
  – How many
    • Beginners initially 1 set = multiple sets
      – 1st 4-6 weeks
    • Generally 3-6 sets for experienced athletes
  – How often
    • Beginners will do well with 1-2 x week
    • Elite level athletes may require 4-5 training sessions a week to maintain or improve strength
Flexibility

• Definitions
  – Most commonly refers to range of motion around a joint
    • Joint motion is affected by muscle and ligament
  – Also refers ability of a muscle to elongate

• Static stretch
  – Stretch to a length and hold without movement

• Active/Dynamic stretch
  – Stretch by movement (joint ROM) or by activation of antagonist muscle

• Proprio-neuro-facilitory (PNF)
  – Combination of muscle contraction and passive force
    • Appears to increase stretch tolerance

• Ballistic
  – Moving to end ROM of a joint the relax then return to end ROM using a bouncing technique
Flexibility

• Injury prevention and treatment
  – Both inflexible and highly flexible athletes appear to have increased injury risk
    • No studies to show that improving flexibility of an inflexible athlete with decrease their risk
  – Stretching before exercise does not appear to decrease injury risk
    • Muscle are weaker after stretching? Increased risk
  – Regular stretching
    • Some evidence (minimal) to suggest decreased injury risk
Flexibility

• Performance
  – Acute stretching decreases the muscles ability to generate force and velocity
  – Over weeks stretching will increase muscles ability to generate force
    • ? % contribution to total athletic performance
Athletic Development

• “Athleticism—the ability to express one’s physical self with optimal speed, agility, strength, balance, suppleness, stamina and grace while avoiding injury—is the goal. Strength, as you will note by re-reading the sentence, above, is a single element of the collective term: athleticism. You cannot be athletic without being strong; but you can be strong without being athletic. “

– Steve Myrland CSCS
Athletic Development

• Skill specific strength and training
  – When possible individualized training is best
  – Not all athletes can tolerate the same loads
    • Genetics
    • Injury or previous injury
    • Years of training
  – Understanding the demands of the sport help guide functional training
    • Combines cardiovascular and strength work that mimic demands of the specific sport
Injury prevention

• Data on injury prevention is limited
  – Just being strong doesn’t mean you won’t get hurt
• Generalized strength training does not appear to have an overall effect on injury rates
• Specific injury training has some evidence of protection
  – Eccentric hamstring exercises have been shown to decrease rates of hamstring strain
  – Neuromuscular training may help prevent knee injuries
Pearls and Pitfalls

• Individualized training is better
  – Not always possible so use non-linear training for groups

• To slow, to little, to infrequent can be just as detrimental to a competitive athletes as to much, to fast, to soon.
  – Monitor loads when possible

• Older athletes and children can benefit from training and it is safe
  – Slower gains
  – Neuromuscular control only pre-puberty