Strength Training within an Adaptive Athlete Population

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AGENDA

- Discuss the strength training literature
- List current ACSM recommendations
- Summarize basic philosophies in strength training
- Apply strength training considerations to an adaptive athlete population
Science of Strength Training
Physiology of Strength Training

- A form of body adaptation
- Alters the musculoskeletal system:
  - Change storage of nutrients
  - Amount of metabolic enzymes
  - Amount of contractile protein
  - Stiffness of connective tissues
- Alters mitochondria at cellular level
- Adaptations most visible after 8-12 weeks of training
- Gives you endurance and strength for sport

Hughes and Elllefson, 2018
Characteristics of “Aged” Muscle

- Decreased fiber size, increased extracellular connective tissue and crosslinks, increased mechanical stiffness, decreased satellite cell density

Increase stiffness and extracellular matrix would decrease joint range of motion

Decreased satellite cell number is a deficit
- Hypertrophy, Lengthening, Repair and impact on rehabilitation and therapy

Lieber, 2022
Aerobic vs Anaerobic Training

<table>
<thead>
<tr>
<th>Aerobic</th>
<th>Anaerobic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low load, long duration</td>
<td>• High load, short duration</td>
</tr>
<tr>
<td>• Focus on type I muscle fibers (more endurance)</td>
<td>• Focus on type II muscle fibers (more power and size)</td>
</tr>
<tr>
<td>• More oxygen present in cells</td>
<td>• Higher energy expenditure during recovery</td>
</tr>
</tbody>
</table>
Endurance Training vs. Strength Training

- Depends on sport
- Low-intensity exercise endurance requires low power, long duration
- High-intensity exercise endurance requires higher power, often time shorter duration
- Research suggest strength training improves endurance sport performance
- Research shows concurrent training of endurance and strength training improves physical fitness compared to single training

(Bazyler et al., 2015) (Gabler et al., 2018)
Training Parameters
ACSM – Strength Training – Frequency

- At least 30 mins of moderate-intensity physical activity, 5x a week OR 20 minutes of vigorous activity 3x a week
- Strength training at least 2 days a week, 8-12 reps of 8-10 different exercises (non-consecutive days)
  - 2-3 days a week for novice
  - 3-4 days a week for intermediate
  - 4-6 days a week for advanced

https://www.prescriptiontogetactive.com/static/pdfs/resistance-training-ACSM.pdf
Resistance Training Benefits

- Can utilize free weights, machines, resistance bands, or body weight
- Increase weight of lean muscle
- Increase loss of fat weight
- Increase resting metabolism

https://www.acsm.org/docs/default-source/files-for-resource-library/resistance-training-for-health.pdf?sfvrsn=d2441c0_2
Exercise Prescription

- Consider the intent:
  - Where are you deficient?
  - What do you need for your sport?
- Consider the ‘load’ (how much weight)
- Consider the ‘volume’ (how many reps and sets)
- Consider the rest between sets
- Safety first!
ACSM – Strength Training – Goals

- Muscular Strength – Max external force (one rep max)
  - 60-100% 1RM, 1-6 reps, 2-6 sets
  - 2-3 minute rest between sets

- Muscular Power – Optimal amount of work performed in given time period
  - Up to 60% 1RM, 3-6 reps, up to 3 sets
  - 2-3 minute rest between sets

- Muscular Hypertrophy – Muscle size
  - Up to 100% 1RM, 8-12 reps, 1-6 sets
  - 2-3 minute rest between sets

- Muscular Endurance – Repeated submax contraction
  - Under 70% 1RM, 10-25 reps, 2-4 sets
  - Rest 30sec – 1 minute between sets

https://www.prescriptiontogetactive.com/static/pdfs/resistance-training-ACSM.pdf
ACSM – Strength Training

- **Muscular Strength** – Max external force (one rep max) (track and field)
  - High force, low reps, longer breaks

- **Muscular Power** – Optimal amount of work performed in given time period (tennis, soccer, baseball, basketball)
  - Moderate force, moderate reps, longer breaks

- **Muscular Hypertrophy** – Muscle size (power lifter)
  - High force, high reps, longer breaks

- **Muscular Endurance** – Repeated submax contraction (long distance runner, soccer)
  - Low-moderate force, high reps, short breaks

https://www.prescriptiontogetactive.com/static/pdfs/resistance-training-ACSM.pdf
Recommendations

- Though for beginners, it may be more useful to train with multiple sets at a light weight to learn proper form. Single set may be more important when an elderly person is starting out; they would also progress more slowly.

- Athletes may benefit from shorter, more focused workouts. When trying to prescribe exercise to general public, always trying to find most efficient way to work out with the most compliance.

- Women athletes may have very different goals than casual weightlifters.

- Determine what is tolerable vs. what is harmful.
Endurance

- Despite the limited research on Cross Training for highly trained cyclists, it is likely that replacing a portion of a cyclist’s Endurance Training (ET) with Resistive Training (RT) will result in improved time trial performance and maximal power.

- The authors recommend replacing a portion of an athlete’s ET volume with explosive RT to increase Time trial performance and maximal power output and to minimize the risk of fatigue from an overwhelming total training volume. *YAMAMOTO, L 2010*

- Increased strength & Functional fitness in pulmonary rehab patients, *Phillips 2006*
Cardiac adaptation in endurance athletes

- 200 studies reviewed
- Increase in LVentricular end-diastolic & Left ventricular posterior wall following endurance training
- Physiological hypertrophy
- Runners: values highest in first 2 periods (4 total)
- Cyclists 2nd & third periods of training
- Possible differences if general or sports specific
  - Calderon Montero et al. 2007
Endurance training

- Natural LHTL provides the best protocol for enhancing endurance performance in elite and subelite athletes while some artificial protocols are effective in subelite athletes.

- Live High, Train Low

- Meta analysis
  - Bonetti & Hopkins 2009
Overtraining and Safety

- 2-10% increase of load per progression
- Can progress if can perform the workout for 1-2 consecutive training sessions
- Consider large and small muscle groups
  - Small muscle groups can improve performance and reduce risk of injuries

https://www.prescriptiontogetactive.com/static/pdfs/resistance-training-ACSM.pdf
Types of Exercises
Types of Strengthening

- **Isometrics** – The joint angle and muscle length do not change during contraction
- **Isokinetics** – Concentric vs eccentric contraction
- **Plyometrics** – Integrates controlled speeds and forces with various movements, eg ‘explosive’ movements
- Mixture can be beneficial – depends on goals and sport
Muscle groups – Arms

- Consider **large muscles** – Deltoids, pecs, lats, biceps, etc. (push up, bench press, pull down, dumbbell fly)

- Consider **small muscles** (important for injury prevention) – Rotator cuff, mid trap, lower trap, etc. (shoulder external rotation, mid chest rows)
Muscle groups – Core and Back

- Consider **large muscles** – Rectus abdominis, lats (pull downs, sit ups)
- Consider **small muscles** (important for injury prevention) – lumbar extensors, transversus abdominus (planks and supermans)
**Muscle groups – Legs**

- Consider **large muscles** – quads, gluts, calves (squat, jumps, deadlift)

- Consider **small muscles** (important for injury prevention) – glut medius, hip external rotators, foot intrinsic (clams, lateral band walk, toe curls)
Literature on Exercise for Best Muscle Strength

- Suchomel et al. (2018)
  - Bilateral training
  - Eccentric training (same weight, longer descent)
  - Accentuated eccentric loading (more weight during longer descent)
  - Variable resistance training (chains and resistance bands)
  - “train to failure” not required
Practice

- Kotte et al. 1978
- Practice is essential for the development of a high level of competence in any skill, many adults have little information on how much practice is needed
  - Basketball shooting 1 million shots
  - Football passing 1.4 million passes
  - Baseball pitches 1.6 million pitches
- Expert performance intense deliberate practice for a minimum of 10 years. Ericsson et al 1993
Muscle Recovery

- Soreness within 24-48 hours
- Due to cellular waste product accumulation in muscle cells → Inflammation
- Or via micro-tears to muscle fibers

Muscle Recovery

- Ways to enhance muscle recovery:
  - Dynamic warm up
  - Active cooldown
  - Stretching after HR returns to resting
  - Foam rolling or massage
  - Hydration (5-10ml/kg of body weight)
    - Eg 150bs person drinks .5-2.5 cups of fluid before exercise
  - Nutrition
  - Cold therapy
  - Compression
  - Sleep and rest (at least 8 hours)

Sample Program Upper body and Core

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm up</td>
<td>Arm bike, 5 minutes</td>
</tr>
<tr>
<td>Bench press</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Lat Pull down</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Deltoid Fly</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Rows</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Bicep curl</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Tricep pull down</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Pull up</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>RTC external rotation</td>
<td>Light resistance band, 10-15 reps</td>
</tr>
<tr>
<td>Forward plank</td>
<td>1-2 minute</td>
</tr>
<tr>
<td>Abs bicycles</td>
<td>10-15 reps</td>
</tr>
<tr>
<td>Rest 2-3 minutes, repeat</td>
<td></td>
</tr>
<tr>
<td>circuit x 3-4</td>
<td></td>
</tr>
</tbody>
</table>
Sample Program Lower body and Core

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm up</td>
<td>Stationary bike, 5 minutes</td>
</tr>
<tr>
<td>Weighted squat</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Deadlift</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Weight bridge</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Calf raises</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Quad extensions</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Hamstring curls</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Leg press</td>
<td>50% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Lateral band walks</td>
<td>Light resistance band, 10-15 reps</td>
</tr>
<tr>
<td>Forward plank</td>
<td>1-2 minute</td>
</tr>
<tr>
<td>Abs bicycles</td>
<td>10-15 reps</td>
</tr>
<tr>
<td>Rest 2-3 minutes,</td>
<td>repeat circuit x 3-4</td>
</tr>
</tbody>
</table>
## Sample Program Full Body Plyometrics

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm up</td>
<td>Elliptical, 5 minutes</td>
</tr>
<tr>
<td>Thrusters</td>
<td>20% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Burpees</td>
<td>20% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Lateral bound</td>
<td>20% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Lunge to driver</td>
<td>20% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Agility ladder</td>
<td>20% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Box jumps</td>
<td>20% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Ball throws</td>
<td>20% 1RM, 6-10 reps</td>
</tr>
<tr>
<td>Clamshells with band</td>
<td>Light resistance band, 10-15 reps</td>
</tr>
<tr>
<td>RTC internal rotation</td>
<td>Light resistance band, 10-15 reps</td>
</tr>
<tr>
<td>Abs rotation</td>
<td>10-15 reps</td>
</tr>
<tr>
<td>Rest 2-3 minutes, repeat circuit x 3-4</td>
<td></td>
</tr>
</tbody>
</table>
## Sample Weekly Program – Intermediate/Advanced – Soccer Player

<table>
<thead>
<tr>
<th>Day of Week</th>
<th>Training Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Lower body and core strength training</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Upper body and core strength training</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Endurance training</td>
</tr>
<tr>
<td>Thursday</td>
<td>Recovery day – Stretch and Ice</td>
</tr>
<tr>
<td>Friday</td>
<td>Full Body Strengthening with Plyometrics</td>
</tr>
<tr>
<td>Saturday</td>
<td>Club game or practice</td>
</tr>
<tr>
<td>Sunday</td>
<td>Recovery day – Stretch and Ice</td>
</tr>
</tbody>
</table>
Adaptive Sports Considerations
Risk Considerations

- Prevalence of medical illness is 2x as high in Paralympic athletes compared to Olympic athletes
- Complications include impairment of nervous system, cardiorespiratory system, thermoregulatory system, GI system and musculoskeletal system
- Medical management is key – Talk with your doctor!
- Gradual progression of strength training is essential to safety
Conclusion and Take Aways
Conclusion

- Consider parameters depending on sport needs
- Don’t forget about endurance training
- Progress as appropriate – Need to challenge to grow
- Recovery is essential
- Hydration, nutrition, and rest are important
- Practice of sport is key
- Safety comes first
References


Questions?

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