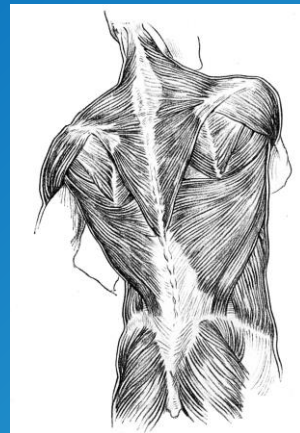


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# Strength Training within an Adaptive Athlete Population

Winter 2023

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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



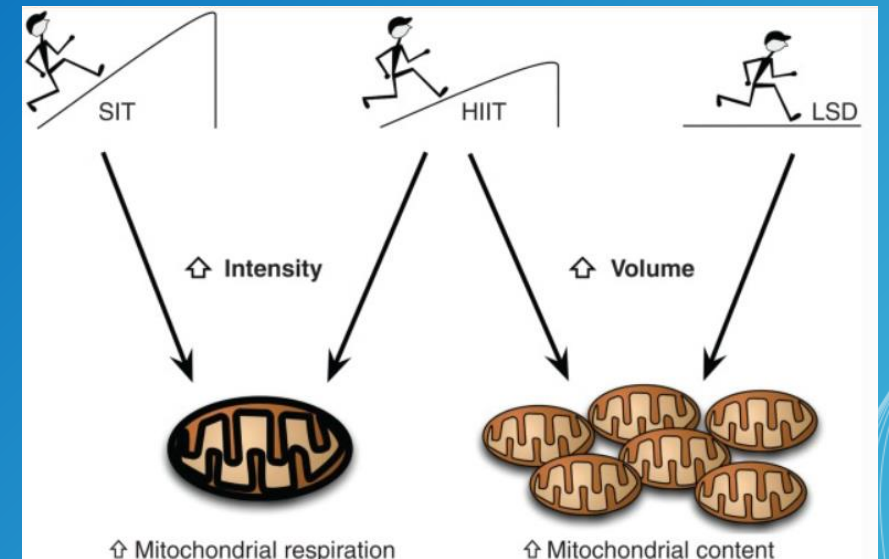
# Science of Strength Training

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# 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



# CP MUSCLE



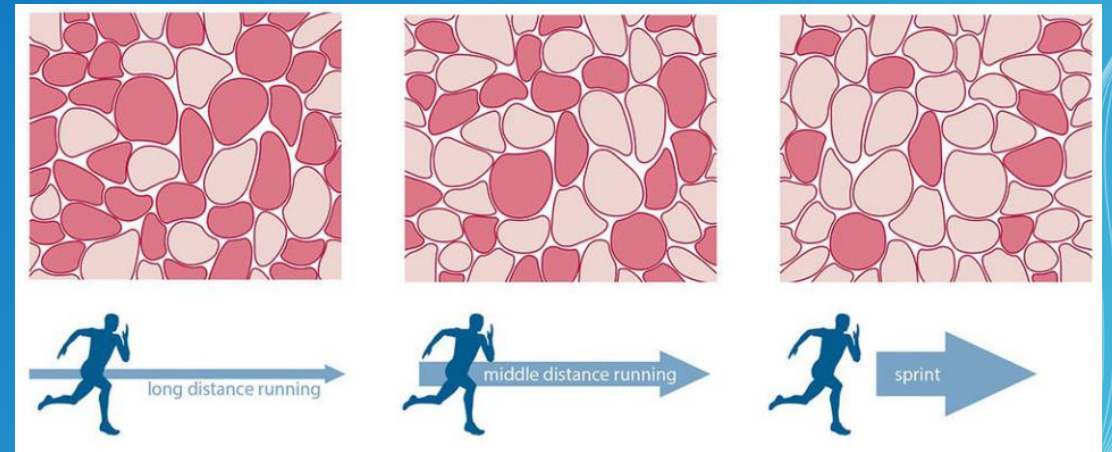
- Characteristics of “Aged” Muscle
  - Decreased fiber size, increased extracellular connective tissue and crosslinks, increased mechanical stiffness, decreased satellite cell density
- Increase stiffness and extracellular matrix would decrease joint range of motion
- Decreased satellite cell number is a deficit
  - Hypertrophy, Lengthening, Repair and impact on rehabilitation and therapy



# Aerobic vs Anaerobic Training



Aerobic	Anaerobic
<ul style="list-style-type: none"><li>• Low load, long duration</li><li>• Focus on type I muscle fibers (more endurance)</li><li>• More oxygen present in cells</li></ul>	<ul style="list-style-type: none"><li>• High load, short duration</li><li>• Focus on type II muscle fibers (more power and size)</li><li>• Higher energy expenditure during recovery</li></ul>



# 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

# Training Parameters



# ACSM – Strength Training – Frequency



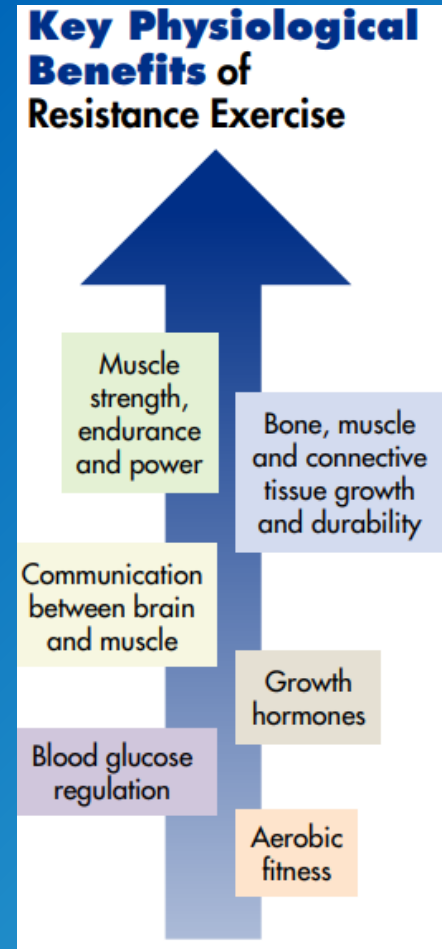
- At least 30 mins of moderate-intensity physical activity, 5x a week OR 20 minutes of vigorous activity 3x a week
- Strength training at least 2 days a week, 8-12 reps of 8-10 different exercises (non-consecutive days)
  - 2-3 days a week for novice
  - 3-4 days a week for intermediate
  - 4-6 days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



# 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



## Resistance Exercise Can Help Manage and Treat Many Conditions Including:

### Including:

- Arthritis
- Cancers
- Cardiovascular disease
- Dementia
- Depression
- Diabetes
- Fall risk
- Frailty
- Hypertension
- Insomnia
- Low back pain
- Mental health
- Movement disorders
- Obesity
- Osteoarthritis
- Osteoporosis
- Pulmonary disorders
- Peripheral vascular disease
- Stroke

# 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

# 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

# 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



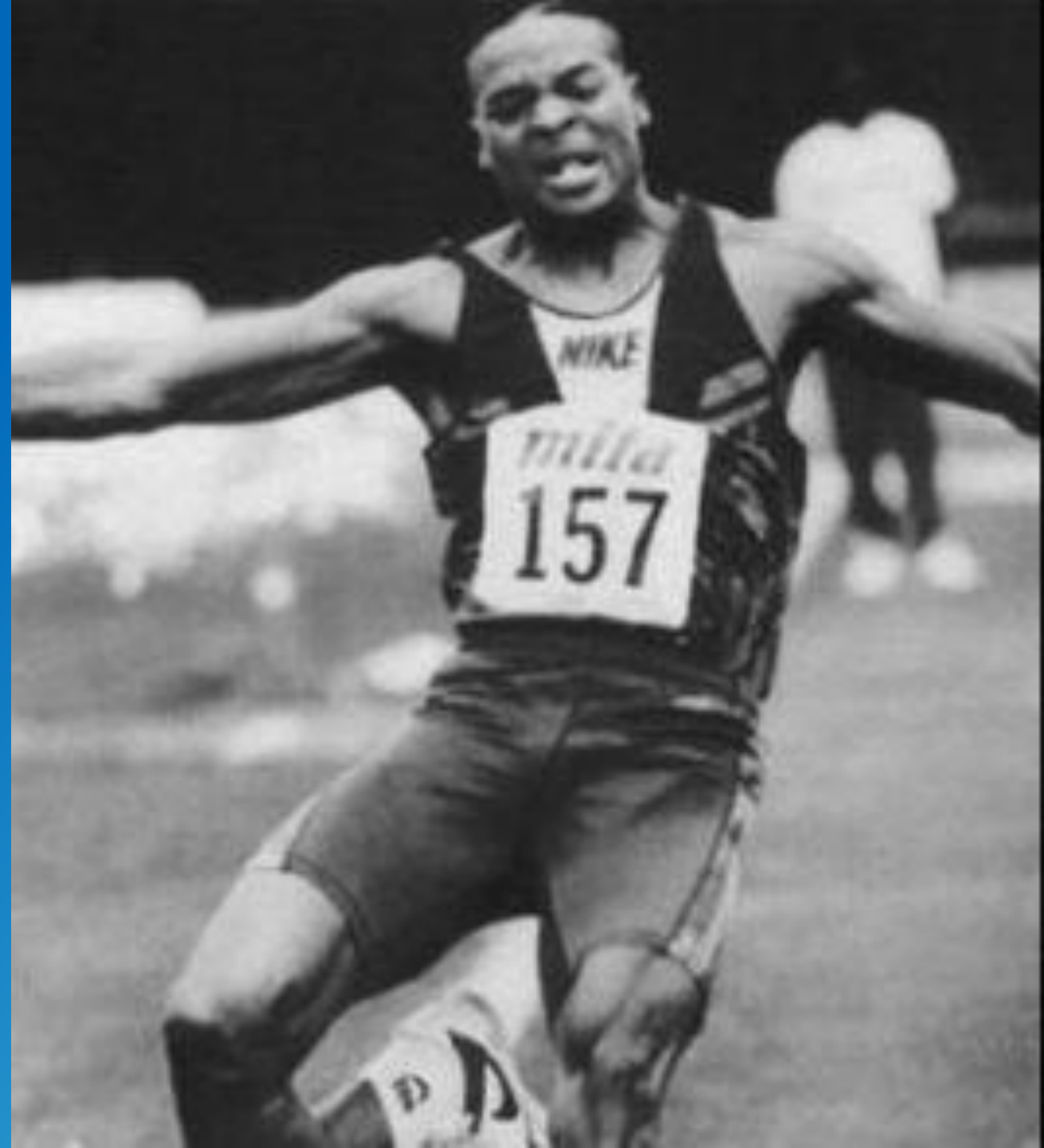
- Despite the limited research on Cross Training for highly trained cyclists, it is likely that replacing a portion of a cyclist's Endurance Training (ET) with Resistive Training (RT) will result in improved time trial performance and maximal power.
- The authors recommend replacing a portion of an athlete's 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 2<sup>nd</sup> & 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



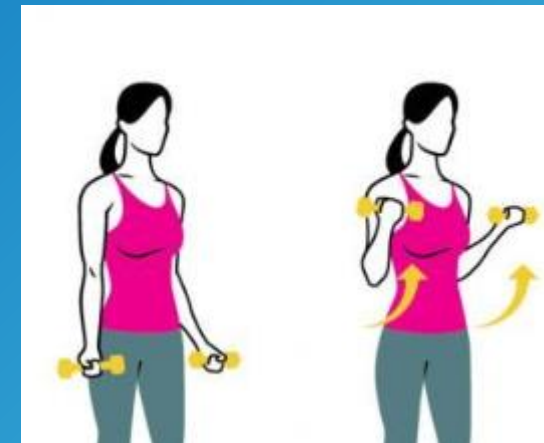
- 2-10% increase of load per progression
- Can progress if can perform the workout for 1-2 consecutive training sessions
- Consider large and small muscle groups
  - Small muscle groups can improve performance and reduce risk of injuries

# Types of Exercises

# Types of Strengthening



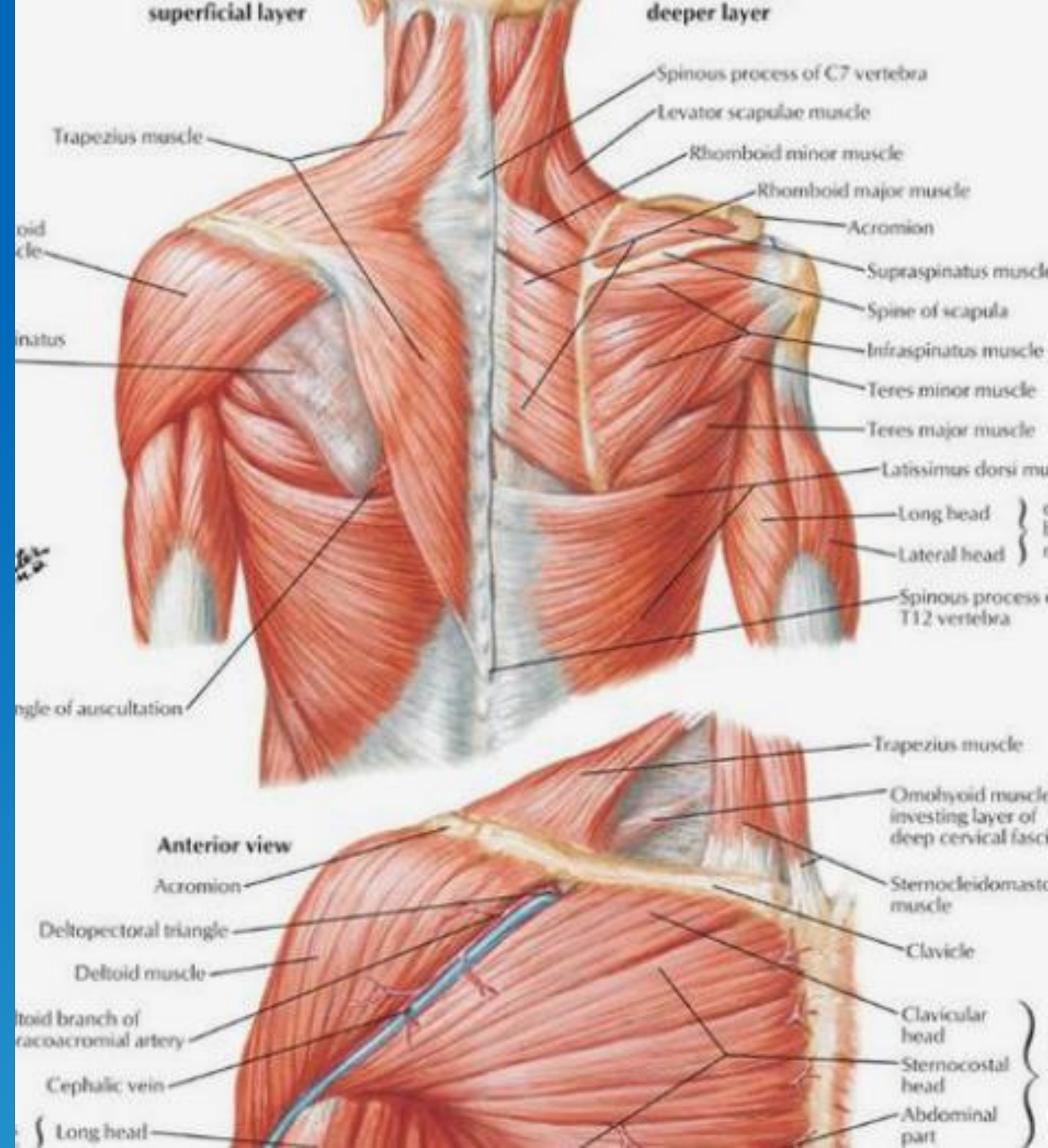
- **Isometrics** – The joint angle and muscle length do not change during contraction
- **Isokinetics** – Concentric vs eccentric contraction
- **Plyometrics** – Integrates controlled speeds and forces with various movements, eg 'explosive' movements
- Mixture can be beneficial – depends on goals and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



# Muscle groups – Arms



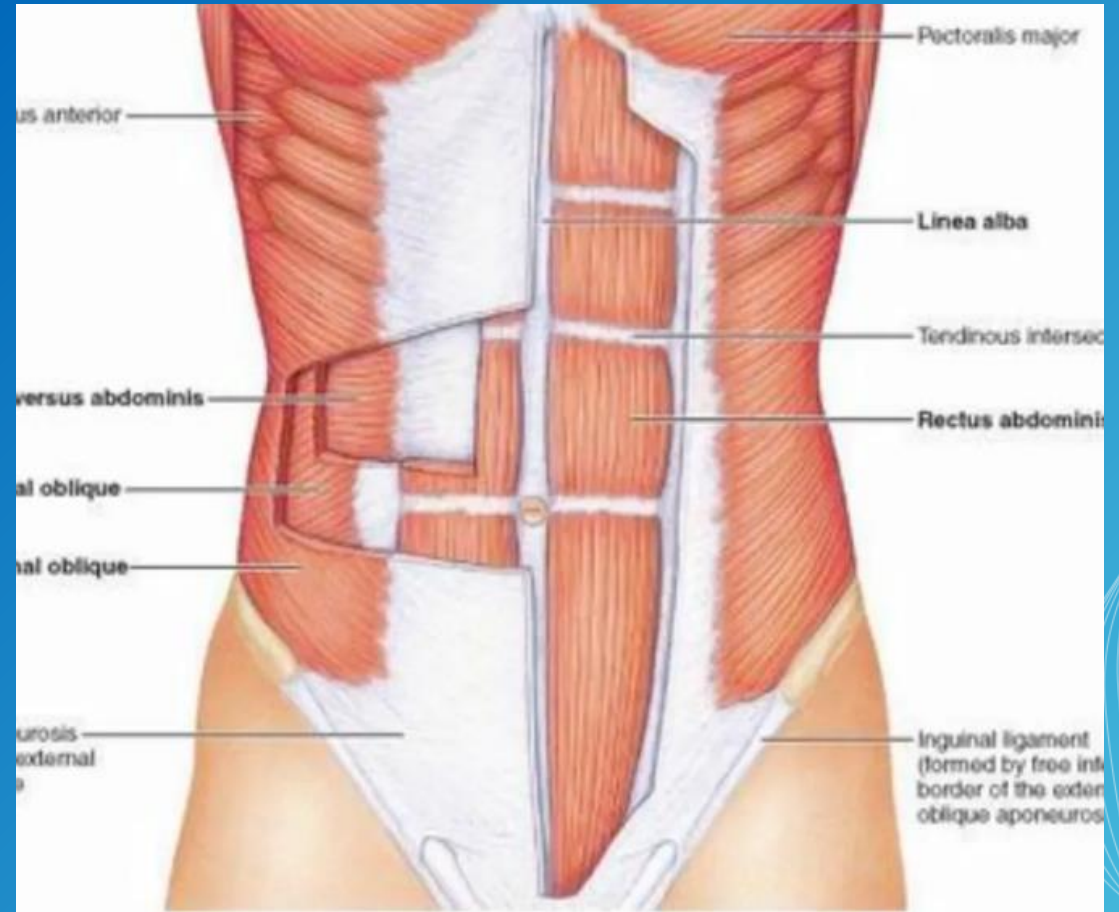
- Consider large muscles – Deltoids, pecs, lats, biceps, etc (push up, bench press, pull down, dumbbell fly)
- Consider small muscles (important for injury prevention) – Rotator cuff, mid trap, lower trap, etc. (shoulder external rotation, mid chest rows)



# Muscle groups – Core and Back



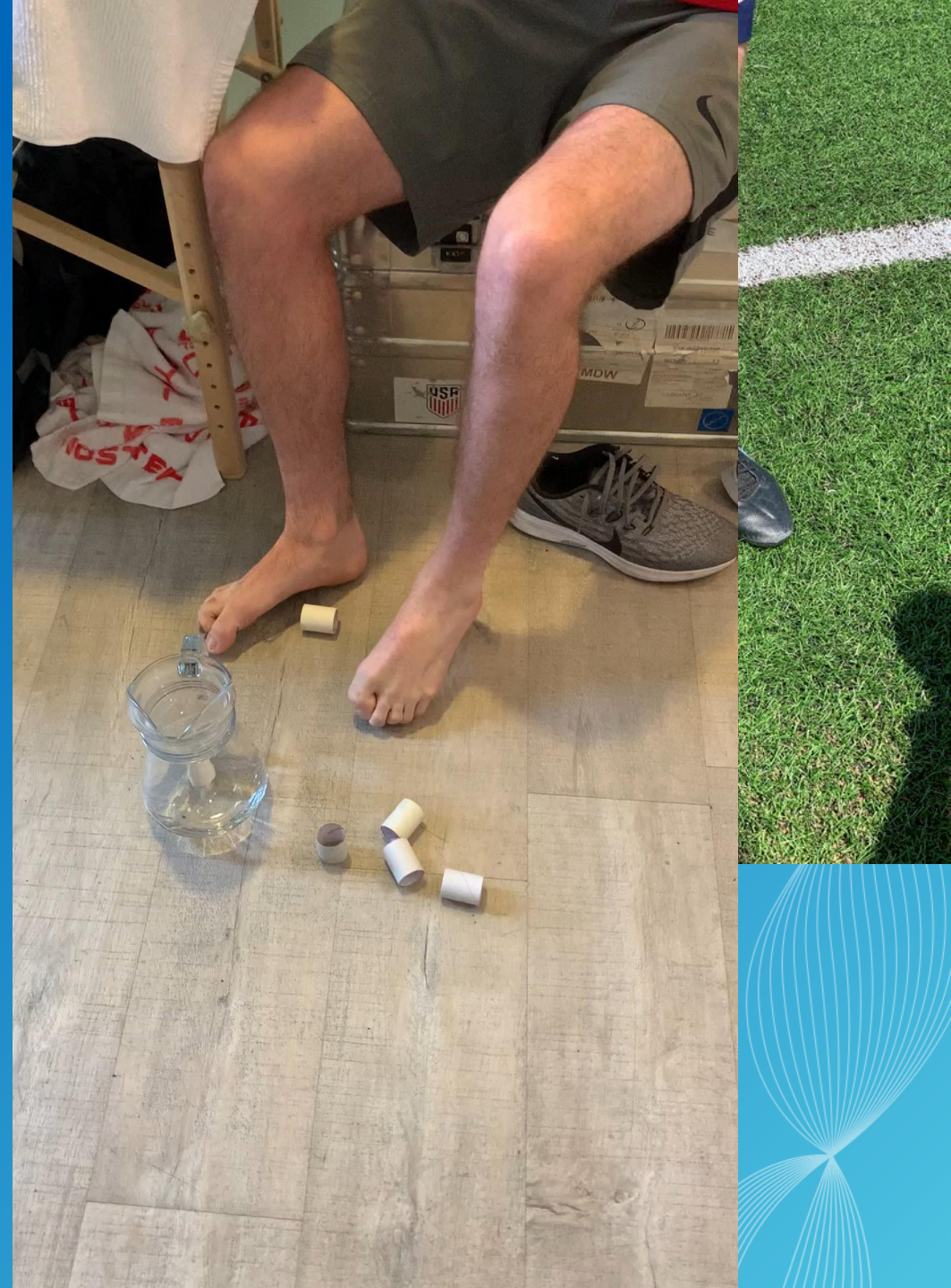
- Consider large muscles – Rectus abdominis, lats (pull downs, sit ups)
- Consider small muscles (important for injury prevention) – lumbar extensors, transversus abdominis (planks and supermans)



# Muscle groups – Legs



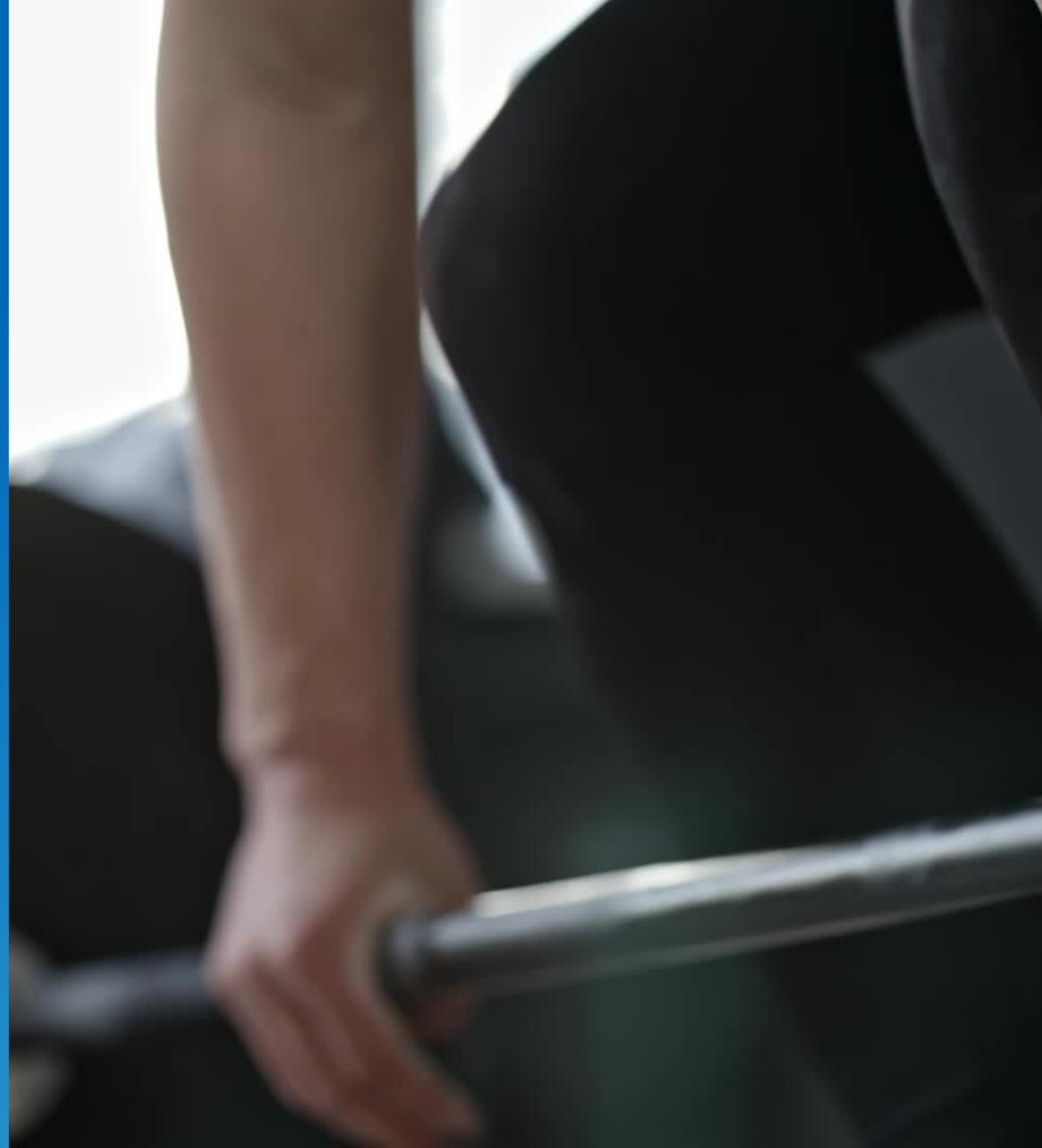
- Consider large muscles – quads, gluts, calves (squat, jumps, deadlift)
- Consider small muscles (important for injury prevention) – glut medius, hip external rotators, foot intrinsic (clams, lateral band walk, toe curls)



# 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

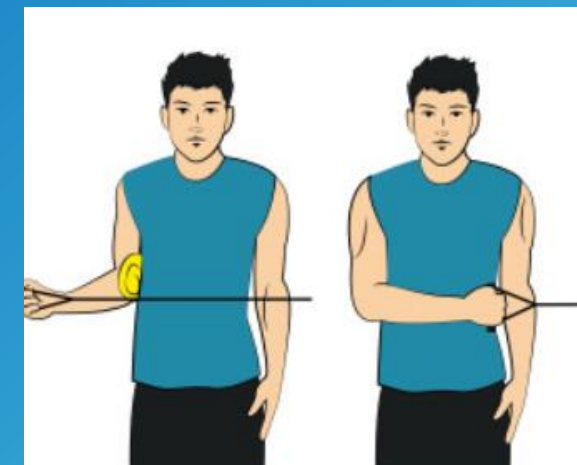
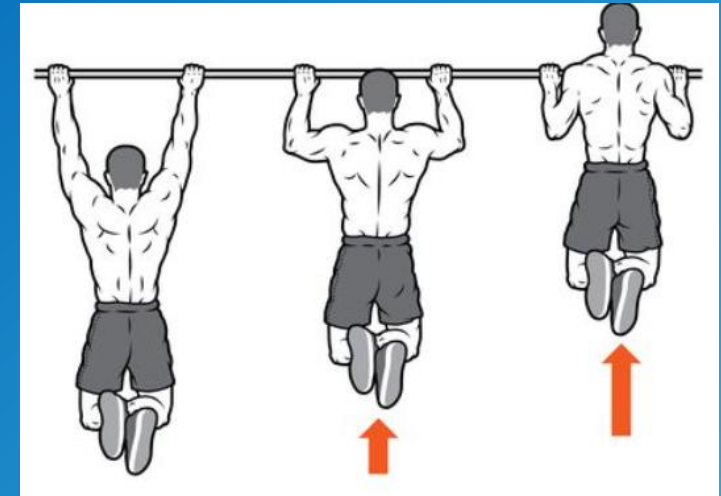


- Ways to enhance muscle recovery:
  - Dynamic warm up
  - Active cooldown
  - Stretching after HR returns to resting
  - Foam rolling or massage
  - Hydration (5-10ml/kg of body weight)
    - Eg 150lb person drinks .5-2.5 cups of fluid before exercise
  - Nutrition
  - Cold therapy
  - Compression
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



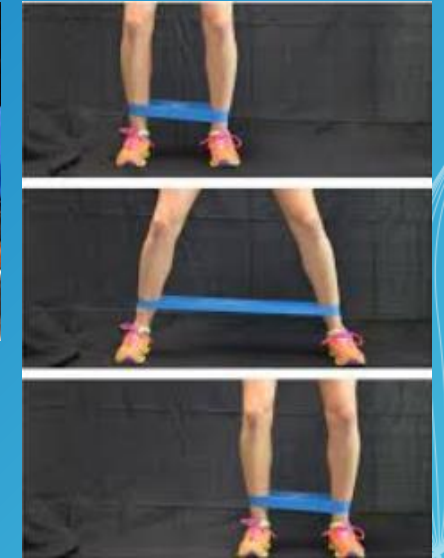
# Sample Program Upper body and Core

Exercise	Parameters
Warm up	Arm bike, 5 minutes
Bench press	50% 1RM, 6-10 reps
Lat Pull down	50% 1RM, 6-10 reps
Deltoid Fly	50% 1RM, 6-10 reps
Rows	50% 1RM, 6-10 reps
Bicep curl	50% 1RM, 6-10 reps
Tricep pull down	50% 1RM, 6-10 reps
Pull up	50% 1RM, 6-10 reps
RTC external rotation	Light resistance band, 10-15 reps
Forward plank	1-2 minute
Abs bicycles	10-15 reps
Rest 2-3 minutes, repeat circuit x 3-4	



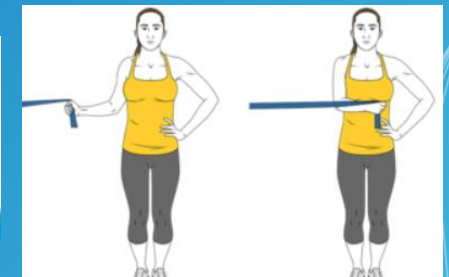
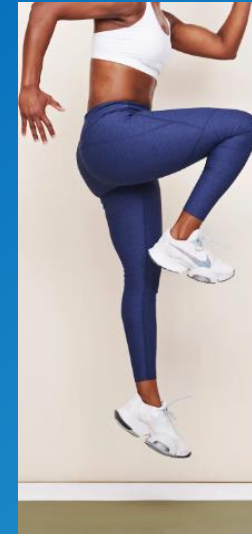
# Sample Program Lower body and Core

Exercise	Parameters
Warm up	Stationary bike, 5 minutes
Weighted squat	50% 1RM, 6-10 reps
Deadlift	50% 1RM, 6-10 reps
Weight bridge	50% 1RM, 6-10 reps
Calf raises	50% 1RM, 6-10 reps
Quad extensions	50% 1RM, 6-10 reps
Hamstring curls	50% 1RM, 6-10 reps
Leg press	50% 1RM, 6-10 reps
Lateral band walks	Light resistance band, 10-15 reps
Forward plank	1-2 minute
Abs bicycles	10-15 reps
Rest 2-3 minutes, repeat circuit x 3-4	



# Sample Program Full Body Plyometrics

Exercise	Parameters
Warm up	Elliptical, 5 minutes
Thrusters	20% 1RM, 6-10 reps
Burpees	20% 1RM, 6-10 reps
Lateral bound	20% 1RM, 6-10 reps
Lunge to driver	20% 1RM, 6-10 reps
Agility ladder	20% 1RM, 6-10 reps
Box jumps	20% 1RM, 6-10 reps
Ball throws	20% 1RM, 6-10 reps
Clamshells with band	Light resistance band, 10-15 reps
RTC internal rotation	Light resistance band, 10-15 reps
Abs rotation	10-15 reps
Rest 2-3 minutes, repeat circuit x 3-4	



# Sample Weekly Program – Intermediate/Advanced – Soccer Player



Day of Week	Training Activity
Monday	Lower body and core strength training
Tuesday	Upper body and core strength training
Wednesday	Endurance training
Thursday	Recovery day – Stretch and Ice
Friday	Full Body Strengthening with Plyometrics
Saturday	Club game or practice
Sunday	Recovery day – Stretch and Ice



# Adaptive Sports Considerations



## Hypertrophy Exercises

A



B



## Endurance Exercises

C



D



**Figure 2.**

Muscle strengthening exercises. Hypertrophy exercises using an 8-repetition maximum resistance for (A) shoulder adduction and (B) shoulder external rotation. Endurance exercises using a 15-repetition maximum resistance for (C) shoulder elevation in the scapular plane and (D) scapular retraction.

Mulroy SJ, Thompson L, Kemp B, Hatchett PP, Newsam CJ, Lupold DG, Haubert LL, Eberly V, Ge TT, Azen SP, Winstein CJ, Gordon J; Physical Therapy Clinical Research Network (PTClinResNet). Strengthening and optimal movements for painful shoulders (STOMPS) in chronic spinal cord injury: a randomized controlled trial. *Phys Ther.* 2011

# 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



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# Questions?

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