The Muscular System III: Neuromuscular Adaptations to Training

PSK 4U
NGDHS – Mr. S. Kelly

Muscle Hypertrophy

• Defined: growth of component cells of skeletal muscle which leads to an overall increase in skeletal muscle size

  • Myofibrillar hypertrophy: refers specifically to an increase in size and number of muscle fibers (contractile components). Includes an increase in myosin and actin contractile proteins within myofibrils.
  
  • Sarcoplasmic hypertrophy: refers to an increase in the volume of non-contractile material in the muscle (water, glycogen, minerals, etc.)

• The general belief is that myofibrillar hypertrophy corresponds to increased strength (and some size) while sarcoplasmic hypertrophy is associated with increased size

Types of Hypertrophy

The photo at right is one way to think of sarcoplasmic vs. myofibrillar hypertrophy
Muscle Atrophy

• Also known as muscle “wasting”
• Generally, a decrease in size and mass of muscles over time
• Causes include but are not limited to:
  • Inactivity
  • Disease
  • Injury
  • Dietary / environmental concerns

Neural Adaptations

• Improved synchronization of motor unit firing ("smoother" strength movements, therefore better/faster movements)
• Improved ability of the body to recruit motor units to perform strength tasks and respond to electrical (nervous) stimuli
• Associated with short term (~8 -20 weeks) increases in strength

Type of training vs. Results

• Recall the FITT principle: type of training varies by
  • Frequency with which training is performed
  • Intensity at which training is performed
  • Type of training performed
  • Time over which training is performed
• Therefore, adaptations to training depend greatly on all four factors listed above
Types of Training vs. Results cont’d

- Specific training is intended for specific results
- Generally: resistance training has little or no effect on aerobic capacity
- The debate: does aerobic training negate the benefits / gains of resistance training? Why?
- Maybe. Evidence / logic suggest that aerobic training develops the aerobic capacities of some muscle fibers at the expense of the glycolytic properties of those same fibers.
- If that is the case, then why is HIIT so effective?

HIIT is effective but…

- The benefits include myofibrillar hypertrophy but also both AEROBIC and ANAEROBIC capacities
- Benefits also include improved cardiovascular health and lower blood pressure, improved insulin sensitivity (muscles can more readily use glucose for fuel while exercising)
- Body COMPOSITION is changed, subjects maintain body mass while reducing body fat %
- So does sarcoplasmic hypertrophy occur here? Maybe. Not really. And if it does, it is relatively temporary.
- So can we improve muscle function, strength, and cardiovascular health at the same time? YES.

Summary of Skeletal Muscle Adaptations to Training

<table>
<thead>
<tr>
<th>Variable</th>
<th>Resistance Training</th>
<th>Aerobic Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of muscle fibers</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Number of muscle fibers</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Movement speed</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Strength</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Aerobic capacity</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Anaerobic capacity</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>
Comparing results by training type

<table>
<thead>
<tr>
<th>Variable</th>
<th>After resistance training</th>
<th>After aerobic training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle fiber size</td>
<td>Increase</td>
<td>Small increase or no increase</td>
</tr>
<tr>
<td>Capillary density</td>
<td>No change or decrease</td>
<td>Increase</td>
</tr>
<tr>
<td>Mitochondrial density</td>
<td>Decreases</td>
<td>Increase</td>
</tr>
<tr>
<td>Myosin</td>
<td>More</td>
<td>No change or less</td>
</tr>
</tbody>
</table>

Connective Tissue Adaptation

- In their role as attachment components linking muscles and bones, ligaments also respond to training.
- Specifically, the cross-sectional area of a tendon increases in response to functional loads (resistance training).
- For ligaments and fascia, moderate loading does not result in tissue growth.
- Some studies suggest that heavy loading results in tissue growth.
- For cartilage, studies show that tissue benefits from weight-bearing exercise AND COMPLETE MOVEMENT THROUGHOUT THE ROM.
- Increasing intensity of exercise does not necessarily increase benefits for cartilaginous tissue.

Connective Tissue Adaptation to Training

<table>
<thead>
<tr>
<th>Variable</th>
<th>After resistance training</th>
<th>After aerobic training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ligament strength</td>
<td>May increase</td>
<td>Increases</td>
</tr>
<tr>
<td>Tendon strength</td>
<td>May increase</td>
<td>Increases</td>
</tr>
<tr>
<td>Bone density</td>
<td>Increase (moderate?)</td>
<td>Increase (moderate?)</td>
</tr>
</tbody>
</table>
What’s Next?

• Energy systems
• Our next lab… related to muscular system!