

Effects of Training on Muscle Performance

Dr Taha Sadig Ahmed .

Physiology Department , College of
Medicine , King Saud University ,
Riyadh

Objectives

- At the end of this lectures the student should be able to :
- 1. Appreciate the effects of physical training on body health in general , and musculoskeletal system in particular .
- 2. Define strength training .
- 3. Identify the two types of hypertrophy .
- 4. know the factors affecting hypertrophy .
- 5. Understand that training induces protein synthesis in muscle .
- 6. Explain the diffrennce between aerobic and anaerobic training .

Aerobic versus Anaerobic Exercise

- Aerobic exercise is that performed →
- (1) at a moderate level of intensity &
- (2) over a relatively long period of time.
- For example, running a long distance at a moderate pace is an aerobic exercise (but sprinting is not) , bicycling .
- Anaerobic exercise
- is exercise intense enough to trigger anaerobic metabolism
- It is used by athletes to promote strength, speed and power and by body builders to build muscle mass.
- Muscles develop differently from the case of aerobic exercise →
- Leading to greater performance in short duration, high intensity activities, which last from mere seconds up to about 2 minutes.
- Any activity after about two minutes will have a large aerobic metabolic component.

Benefits of Exercise Training

- **When properly performed, strength training can provide significant functional benefits and improvement in overall health and well-being, including →**
 - ✓ **Improves motor skills.**
 - ✓ **Increased bone density & prevention of osteoporosis .**
 - ✓ **Improved joint function .**
 - ✓ **Increased strength of muscles, tendons and ligaments .**
- **These help to improve posture, provide better support for joints & thereby to reduce the risk of falls & injury during everyday life activities.**
- **Therefore the potential for injury is reduced .**

- ✓ **Regular exercise increases metabolism and promotes fat loss .**
- ✓ **Elevates HDL (good , beneficial) cholesterol.**
- ✓ **Improves respiratory function .**
- ✓ **Improves cardiovascular function , & prevents or delays development of atherosclerosis .**
- ✓ **Prevents or delays development of diabetes .**
- ✓ **By increasing the levels of dopamine, serotonin and norepinephrine, intense exercise is believed to help improve mood and counter feelings of depression .**
- **For all the above reasons , properly performed physical exercise is considered beneficial because it produces improvement for overall health and well-being .**

➤ Q : What is Strength Training ?

➤ Strength training :is the use of resistance to muscular contraction to build the strength , anerobic endurance and size of muscle .

➤ There are many different methods of strength training, the most common being the use of gravity or elastic hydraulic forces to oppose muscle contraction .

Muscle Hypertrophy

- Muscle hypertrophy is the increase of the size of muscle cells.
- It differs from muscle hyperplasia, which is the formation of new muscle cells.

- **Types of Hypertrophy :**

There are two different types of muscular hypertrophy:

- **1-sarcoplasmic Hypertrophy** : the volume of sarcoplasmic fluid in the muscle cell increases with no accompanying increase in muscular strength.
- Sarcoplasmic hypertrophy is characteristic of the muscles of body builders.
- **2-myofibrillar Hypertrophy** : actin and myosin increase in number and add to muscular strength, as well as a small increase in the size of the muscle.
- Myofibrillar hypertrophy is characteristic of the muscles of weight lifters

Muscle Hypertrophy & Protein Synthesis

- **Progressive overload is considered the most important principle behind hypertrophy, so increasing the weight, repetitions, and sets will all have a positive impact on growth**
- **The first measurable effect is an increase in the neural drive stimulating muscle contraction.**
- **As the muscle continues to receive increased demands, the protein synthetic machinery is upregulated.**
- **This upregulation appears to begin with the second messenger system (including phospholipases, protein kinase C, tyrosine kinase, and others).**

- Repeated exercise increases the number of contractile proteins (actin & myosin filaments) within each muscle fiber.
- When number of contractile proteins increases sufficiently, myofibrils split within each muscle fiber → to form new myofibrils → increase in the number of additional myofibrils → hypertrophy.
- Because skeletal muscle cells are unique in being multinucleate , the number of nuclei can also increase.

Factors Affecting Hypertrophy

- (1) Age : During puberty , in males particularly ,hypertrophy occurs at an increased rate.
 - Natural hypertrophy normally stops at full growth in the late teens.
- (2) Exercise :
- ✓ strength training , short duration, high intensity anaerobic exercises considerably increases hypertrophy .,
 - ✓ Lower intensity , longer duration aerobic exercise generally does not result in very effective hypertrophy .
- (3) Dietary protein : An adequate supply of amino acids is essential to produce muscle hypertrophy.

- (4) Cortisol decreases amino acid uptake by muscle tissue, and inhibits protein synthesis → prevents hypertrophy . .
- (5) Testosterone is one of the body's major growth hormones → promotes anabolism → consequently promotes hypertrophy .
- ✓ That is why exercising males can grow bigger muscles more easily and much faster than exercising women
 - ✓ Therefore , in during sport competition events , testosterone is prohibited , because it is considered a performance-enhancing anabolic drug that interferes with fair & just competition .

Aerobic & Anerobic Training

- Each muscle is composed of combination of 2 types of muscle fibers but one is usually dominant
- (1) Fast-Twitch (white) and (2) Slow-Twitch(red, oxidative) fibers .
- Fast-twitch (white , mostly glycolytic) fibers →
 - ✓ Have lower capillarity& few mitochondria because oxidative metabolism is of secondary importance
 - ✓ Are deficient in myoglobin & capable of anerobic metabolism
 - ✓ Are larger in size for strong & powerful contraction ,
 - ✓ Have extensive sarcoplasmicreticulum for rapid release of calcium
 - ✓ Have many glycolytic enzymes for rapid release of energy
 - ✓ Anaerobic fibers uses its fuel faster than the blood and intracellular restorative cycles can resupply it & the muscle fail (fatigues) fast& more easily than slow-twitch .

- **(2) Aerobic , Slow-twitch (red) fibers →**
- ✓ are rich in capillaries and myoglobin , which binds oxygen , and gives the muscle as a whole its red color . These fibers rely on aerobic metabolism .
- ✓ Have higher capillarity & large number of mitochondria to support high level of oxidative metabolism .
- ✓ Have smaller fibers & innervated with small nerve fibers
- ✓ Fibers are adapted for prolonged muscle activity and do not fatigue quickly .

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- **When the goal of the exercising person is lifting heavier weights → anaerobic strength training will produce hypertrophy + increased muscle**
- **When the goal of the exercising person is not merely lifting heavier weights, but another goal such as body shaping → aerobic exercise, and lower weights can be used, if desired.**
- **At higher loads, the muscle will recruit all muscle fibres possible, both anaerobic ("fast-twitch") and aerobic ("slow-twitch"), in order to generate the most force.**
- **However, at maximum load, the anaerobic fibers contract so forcefully that the aerobic fibers are completely shut out, and all work is done by the anaerobic processes.**
- **In the aerobic regime, the blood and intracellular processes can maintain a supply of fuel and oxygen, and continual repetition of the motion will not cause the muscle to fail (fatigue) easily**

Nutrition & Training

- **Muscular training must be matched by good diet**
- **Adequate protein is → for building skeletal muscle .**
- **High-protein diet does not impair kidney function , unless the person has pre-existing kidney diseases .**
- **An adequate supply of carbohydrates (5-7g per kg) is also needed as a source of energy and for the body to restore glycogen levels in muscles.**
- **Water is consumed throughout the course of the workout to prevent poor performance due to dehydration .**

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