Physiology Team 432

Ninth Lecture: Muscle Performance

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EFFECTS OF TRAINING ON MUSCLE PERFORMANCE

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 difference between aerobic and anaerobic**

Simple exercises to do at home

- ✓ http://www.youtube.com/watch?v=KI8u58hPam4
- ✓ http://www.youtube.com/watch?v=3Eh0sjKxf_M

Types of exercise:

*Aerobic

(1) At a moderate level of intensity.

(2) Over a relatively long period of time.

على سبيل المثال: المشي لمسافة طويلة بسرعة منتظمة (و ليس الركض)، ركوب الدراجة.

*Anaerobic

Definition: is exercise intense enough to trigger anerobic metabolism

يحدث عادة في الرياضيين لاعطاءهم السرعة واللياقة والقوة،وفي كمال الاجسام لبناء العضلات.و في حالة الاناروبيك نحصل على اداء افضل في فترة قصيرة وقوة اكبر تدوم ثواني معدودة الى دقيقتين. ما بعد الدقيقتين نحصل على كمية كبيرة من الايروبيك.

Benefits of Exercise Training

1- Improves motor skills.

2- Increased bone density & prevention of osteoporosis.

3- Improved joint function.

4- Increased strength of muscles, tendons and ligaments.

5- Regular exercise increases metabolism and promotes fat loss.

6- Elevates HDL (good, beneficial) cholesterol.

7- Improves respiratory function.

8- Improves cardiovascular function, & prevents or delays development of atherosclerosis.

9- Prevents or delays development of diabetes.

10- By increasing the levels of dopamine, serotonin and norepinephrine, intense exercise is believed to help improve mood and counter feelings of depression.

It looks a LONG paragraph but it is VERY easy when you go through it ☺

INTRODUCTION

- Intense workouts elevate metabolism for several hours following the workout, which also promotes fat loss
- The body's basal metabolic rate increases with increases in muscle mass [which promotes long-term fat loss and helps dieters avoid yo-yo dieting.
- Weight training also provides functional benefits. As stronger muscles improve posture, provide better support for joints, and reduce the risk of injury from everyday activities.
- Older people who take up weight training can prevent some of the loss of muscle tissue that normally accompanies aging—and even regain some functional strength—and by doing so become less frail (هش) .They may be able to avoid some types of physical disability.
- Weight-bearing exercise also helps to prevent osteoporosis
- The ability of the body to resist the stresses that can result from an injury can be increased by obtaining a greater amount of strength. That is true in the athletic world and it has its advantages in performing everyday activities, such as lifting or carrying objects.

✓ For many people in rehabilitation (اعادة تأهيل) or with an acquired disability such as following stroke or orthopaedic surgery, strength training for weak muscles is a key factor to optimise recovery

✓ Though weight training (anaerobic) can stimulate the cardiovascular system, aerobics training of maximal oxygen uptake is a better cardiovascular stimulus.

✓ One side-effect of any intense exercise is increased levels of neurotransmitters as dopamine, serotonine and norepinephrine, but they can help to improve mood and counter feelings of depression.

يزيل الاكتئاب

STRENGTH TRAINING

DEFINITION: is the use of resistance to muscular contraction to build the strength, anaerobic endurance and size of muscle.

Common Method:

1) The use of gravity
2) Elastic hydraulic forces to oppose muscle contraction

MUSCLE HYPERTROPHY

Definition: Muscle hypertrophy is the increase of the size of muscle cell.

Athletes show extensive muscular hypertrophy

It differs from muscle hyperplasia, which is the formation of new muscle cells.

Types of hypertrophy:

1) **Sarcoplasmic Hypertrophy**: the volume of sarcoplasmic fluid in the muscle cell increases with no accompanying increase in muscular strength.

- Several repetitions (generally 12 or more) against a sub-maximal load facilitates mainly sarcoplasmic hypertrophy (professional bodybuilders and endurance athletes.

Sarcoplasmic hypertrophy is characteristic of the muscles of body builders

2) **Myofibrillar Hypertrophy**: actin and myosin contractile proteins increase in number and add to muscular strength, as well as a small increase in the size of the muscle.

- Maximum load for 2-6 repetitions causes myofibrillated hypertrophy to dominate

Myofibrillar hypertrophy is characteristic of the muscles weight lifters

Progressive overload is considered the most important principle behind hypertrophy.

Progressive overload increase in the weight or repetitions (reps) will all have a positive impact on growth.

1 -The first measurable effect is an increase in the **neural drive** stimulating muscle contraction.

2-As the muscle continues to receive increased demands, the **protein** synthetic machinery is **upregulated**.

(This **upregulation** of protein synthesis appears to begin with the second messenger system (including **phospholipases, protein kinase C, tyrosine kinase**, and others).

Microtrauma

- ✓ is tiny damage to the fibers, may play a significant role in hypertrophy
- ✓ When microtrauma occurs (from weight training or other strenuous activities), the body responds by **overcompensating,** replacing the damaged tissue and adding more, So that the risk of repeated damage is reduced.
- ✓ Progressive overload is essential for continued improvement, as the body adapts and becomes more resistant to stress

(No pain No gain)

Muscular hypertrophy can be increased through:-

1- Strength training.

2- Duration & intensity :

- ✓ Short duration, high intensity anaerobic exercises.
- ✓ Lower intensity, longer duration aerobic exercise generally does not result in very effective tissue hypertrophy.

Hypertrophy Mechanism & Protein Synthesis

EXCERCISE hypertrophy is due to increase in contractile protein (number of actin &myosin filaments in each muscle fiber = muscle cell).

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.

The additional contractile proteins appear to be incorporated into existing myofibrils (the chains of sarcomeres within a muscle fiber). -There appears to be some limit to how large a myofibril can become.

That is, hypertrophy results primarily from the growth of each muscle cell, rather than an increase in the number of cells.

Factors Affecting Hypertrophy

1) **Age:** Natural hypertrophy normally stops at full growth in the late teens.

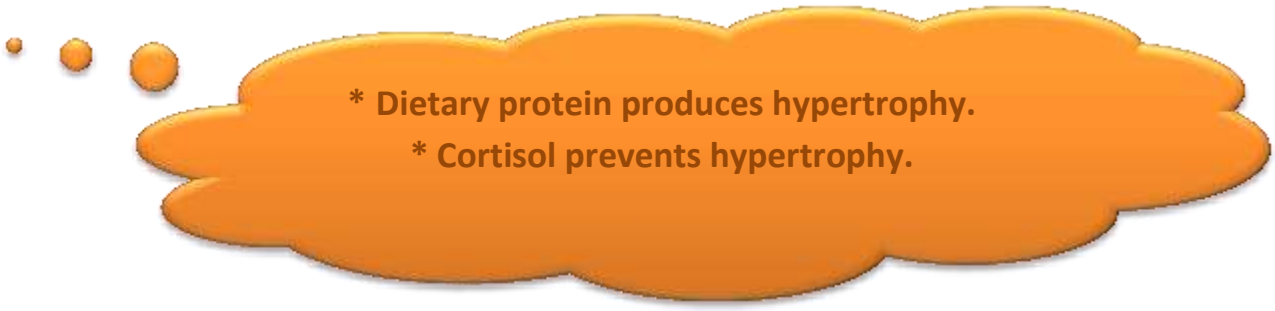
2) **Exercise:**

A- Anaerobic increase hypertrophy.

B- Aerobic 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) Testosterones one of the body's major growth hormones → increases amino acid uptake by muscle tissue, and increases protein synthesis → promotes anabolism → consequently promotes hypertrophy.

لذلك نلاحظ ان عضلات الرجل اكبر من المرأة وذلك لكثرة التستريسترون عند الرجل.

- Taking additional testosterone, as in athletes taking anabolic steroids, this will increase results.
- It is also considered a performance-enhancing drug

AEROBIC & ANEROBIC TRAINING

Each muscle is composed of combination of 2 types of muscle fibers but one is usually dominant.

Types Of Muscle Fiber:

FAST-TWITCH (WHITE , MOSTLY GLYCOLYTIC) FIBERS	AEROBIC , SLOW-TWITCH (RED) FIBERS
Have lower capillarity& few mitochondria (because oxidative metabolism is of secondary importance)	Are rich in capillaries and myoglobin, which binds oxygen (gives the muscle as a whole its red color)
Are deficient in myoglobin & capable of anaerobic metabolism	Have higher capillarity & large number of mitochondria(support high level of oxidative metabolism)
Are larger in size for strong & powerful contraction	Have smaller fibers & innervated with small nerve fibers
Have extensive sarcoplasmic reticulum (for rapid release of calcium)	Fibers are adapted for prolonged muscle activity and do not fatigue quickly
Have many glycolytic enzymes (for rapid release of energy)	
Anaerobic fibers use its fuel faster than the blood and intracellular restorative cycles can resupply it. the muscle fail (fatigues) fast& more easily than slow-twitch	

Anaerobic & aerobic training

- ✓ It was generally considered that consistent anaerobic strength training will produce hypertrophy over the long term, in addition to its effects on muscular strength and endurance.
- ✓ Weight training is commonly perceived as anaerobic exercise, because one of the more common goals is to increase strength by lifting heavy weights.
- ✓ At higher loads, the muscle will recruit all muscle fibers 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 anaerobic muscle fibre uses its fuel faster than the blood and intracellular restorative cycles can resupply it& the muscle fail fast
- ✓ 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
- ✓ Other goals such as weight loss or body shaping often use low weights, adding aerobic character to the exercise.

NUTRITION & TRAINING

- It is widely accepted that muscular training must be matched by changes in diet in order to be effective.
- Adequate proteins generally believed to be required for building skeletal muscle.
- Weight trainers consume a high-protein diet with from 1.4 to 3.3 g of protein per kg of body weight per day.
- Protein that is neither needed for cell growth and repair nor consumed for energy is converted by the liver into fat , which is then stored in the body.
- Some people believe that a high-protein diet entails risk of kidney damage, but studies have shown that kidney problems only occur in people with previous kidney disease
- The deamination of proteins process creates urea, which places low, but consistent, strain on the nephrons.
- 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.

- **A light, balanced meal prior to the workout (usually one to two hours beforehand) ensures that adequate energy and amino acids are available for the intense bout of exercise.**
- **The type of nutrients consumed and nutrient timing affects the response of the body.**
- **Water is consumed throughout the course of the workout to prevent poor performance due to dehydration**
- **Protein and carbohydrates are consumed prior to and after workout has a beneficial impact on muscle growth**
  - ✓ **1- Protein shake is often consumed immediately following the workout, because both protein uptake and protein usage are increased at this time.**
  - ✓ **2- Glucose (or another simple sugar) is often consumed following workout since this quickly replenishes any glycogen lost during the exercise period.**
- **To maximize muscle protein anabolism, recovery drink should contain glucose (dextrose), protein (usually whey) (ماء اللبن) hydrosylate containing mainly dipeptides and tripeptides, and leucine.**

ملاحظات:

١)عندما يكون الهدف من التمارين حمل الاثقال ← يكون انارويبك وينتج

(Increased muscle + Hypertrophy)

٢)عندما يكون الهدف تشكيل الجسم (Body Shaping) ← يكون ايرويبك.

٣) في الاحمال الثقيلة يتم توظيف جميع العضلات الممكنة في كل من الايروبيك والانارويبك لكي تعطي اقصى طاقة، ولكن في اقصى حمل الياف الانارويبك سوف تعمل بقوة كبيرة وتوقف عمل الايروبيبك (العمل يكون على الايروبيك).

GOOD LUCK