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Impact of exercises on muscular, respiratory and circulatory body systems

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Abstract
The purpose of this paper is to explore various changes in different systems of the body with respect to the physiological mechanisms involved as well as to the relevant training factor. The teachers of physical education, coaches, sports persons and students of physical education must be aware about the effects of physical exercises training on various systems to realize the qualitative changes in the body for better performance.

Keywords: exercises, physical activity, body systems, sports

1. Introduction
The effects of exercise on your various body systems are felt both immediately and over time. When you begin exercising, you'll be aware of more frequent muscle contraction, an elevated body temperature and heart rate and an increase in your breathing rate. As your body adapts to a regular exercise regimen, you'll see longer-term positive training effects, such as a larger heart, denser bones and an ability to breathe more deeply. Regular exercise offers many positive benefits that will keep you living independently and reduce your risks of getting certain diseases and injuries. Although gyms and fitness boot camps are places where people typically exercise, you can strengthen your body by taking long hikes or walks, dancing a few hours of salsa or playing your favorite sport. You'd be having so much fun that you'd forget the benefits that exercise gives you.

2. Effect of Physical exercises on Muscular system
About half the weight of our body is our muscles. They make our body to move. There are about 650 muscles in our body and each one helps us in producing a particular movement. Muscles move our body with the help of bones. Blood is pumped throughout our body by the heart muscles. Severa I movements activities of our body require many muscles working together.
There are three major muscle contractions namely: Isotonic Contractions
Isometric Contractions and lsokinetic contractions.
Isotonic or dynamic or concentric contraction is muscle contraction in which the muscle shortens with varying (different) tension while lifting a constant load.
Isometric or static or eccentric contraction is muscle contraction in which tension is developed but there is no change in the length of the muscle.
Isokinetic contraction is muscle contraction executed (performed) at a constant speed and in such a manner that the tension developed by the muscle while shortening is maximal over the full range of joint motion.
Physical Exercises/Training, particularly resistance or weight training, affects our muscular system to a great extent. Many parameters of muscular system get changed after resistance training.
These are described here as under

2.1 Hypertrophy of the Muscle
An increase in thickness in individual muscle fiber is called hypertrophy. Gains in strength and muscular endurance usually depend on the size of individual muscle fibers. In the hypertrophy (increase in size) of muscle the physical training especially weight training causes the following effects:
- Due to resistance training the size of muscle fibers increases.
- Total amount of proteins increases, which is essential for muscle growth.
- Capillary density per fiber also increases which causes more energy production.
- Amount of connective tissues increases.
- Blood supply in the muscles increases.
- Due to hypertrophy muscular strength and muscular endurance increases.

2.2 Biochemical Changes in Muscles
Aerobic Changes.
- Myoglobin content increases. Myogobin is an oxygen-binding compound found in muscle tissue which acts as an oxygen store and helps in diffusion of oxygen.
- Oxidation (breakdown) of carbohydrates and fat increases.
- Number of mitochondria also increases thus more muscular energy is produced.
- Level of activity of concentration of enzymes increases. Enzymes are protein compound that speed up chemical reactions in the muscles.
- Amount of glycogen store increases as a result of training. Glycogen is essential for energy production in the muscles.

Anaerobic changes
- ATP+PC System capacity increases thereby more energy is released. ATP means Adeno Tri

Phosphate and PC means Phosphocreatine. ATP-PC system is an anaerobic energy system in which ATP is manufactured when PC is broken down.

- Glycolytic capacity also increases as a result of training.

2.3 Body Composition Changes

- For most individuals weight or resistance training produces little or no change in total body weight but the body composition changes considerably.
- There can be significant losses of relative and absolute body fat.
- Fat free weight or muscle mass increases significantly.
- Change in Muscle and Joint Motion also takes place.
- After training flexibility increases which play an important role in physical activities and sports to enhance the performance and prevent serious muscular injury.

2.4 Summary of Effects of Physical Training on Muscular System

- The size of muscle fibers increases.
- Amount of Protein increases.
- Capillary density per fiber increases.
- Amount of connective tissue increases.
- Blood supply in the muscles increases.
- Myoglobin content increases.
- Oxidation of carbohydrates and fats increases
- Number of mitochondria (Power house of cell) increases.
- Level of activity of Concentration of enzymes and amount of glycogen store increases.
- ATP-PC and glycolytic capacity increases.
- Total and relative body fat decreases.
- Fat free-weight (muscle mass) increases.
- Flexibility increases.

3. Effect of Physical exercises on Respiratory system

Before describing the impact of Physical exercises or training on respiratory system, one must have knowledge about this system. Nutrients release energy for doing any work or activity; the process of release of energy from nutrients is called respiration. The respiration system consists of organs responsible for taking in oxygen for respiration and releasing carbon dioxide and water vapors, which are the waste products formed during respiration. The passages in the nose, windpipe (trachea), bronchi, lungs and air sacs are the main organs of the respiratory system. Many parameters of respiratory system get affected due to physical exercises/training particularly aerobic or endurance training. These effects are as under:

3.1 Lung Volume

With endurance training lung volume and capacities increase. Vital capacity, which is maximal volume of air forcefully, expelled (expired out) after a maximal inspiration is increased 'after endurance training. The trained athletes may have vital capacity of 5-6 liters. Whereas untrained individuals have vital capacity of 3-4 liters.

3.2 Respiratory Rate or Breathing Frequency (BF)

Breathing frequency is the number of breaths per minutes. After training, breathing frequency or respiratory rate is decreased. In normal untrained individual the resting breathing frequency is about 12-20 breaths/minute. Where as in trained athletes or individuals it comes down to 7-8 breaths/minute. This reduction in respiratory rate reflects greater respiratory efficiency resulted by training or physical exercises.

3.3 Maximum Minute Ventilation

Minute ventilation is the amount of air, which inspires or expires in one minute. After training maximum minute ventilation is increased. Maximum minute ventilation in untrained individual is about 100 liter/minute, whereas in trained athletes it is increased to more than 150-160 liter/minute. Highly trained endurance athletes such as rowers can have maximum pulmonary ventilation rates in excess of 240 liter/minute, which is more than twice the rate of untrained individuals.

3.4 Tidal Volume

The tidal volume, which is the amount of air inspired or expired per breath, is also increased as a result of endurance training. In untrained individuals tidal volume is about 500 ml/breath whereas in trained persons it is increased to more than 600-700 ml/breath.

3.5 Ventilatory efficiency

With physical exercises/training particularly endurance training our ventilatory efficiency increases. Normally, 15 liters of air is required to get one liter of oxygen but trained individual gets the same amount of oxygen i.e. one liter from less air i.e. 12 liters. Thus the trained person can get the same amount of oxygen from less air.

3.6 Pulmonary Diffusion

Pulmonary diffusion is the exchange of gases taking place in the alveoli (small air sac in our lungs). During maximal level of exercises more alveoli become active for diffusion. The size of the alveoli is also increased which provides more space to diffusion of gases such as oxygen and carbon dioxide.

3.7 Summary of Effects of Physical Training on Respiratory System

- Lung volume increases as a result of increase in vital capacity.
- Breathing frequency is decreased in trained individuals.
- Maximum minute ventilation is increased after training.
- Tidal volume is also increased.
- Physical exercises enhances ventilatory efficiency.
- Diffusion capacity (gases exchange capacity) is increased.

4. Effect of Physical exercises on Circulatory system

It has been observed in the literature on exercise physiology and sports training that physical exercises or training affects the various parameters of circulatory system in many ways. Physical exercises/training causes

changes in the following parameters of circulatory system.

4.1 Size of heart

Size of the heart is important to all individuals as the blood is supplied to the whole body by this unique pumping machine. The size of the heart gets changed as a result of endurance training. Endurance training of more than twelve-weeks increases the heart's weight and volume, which further increases the thickness of the left ventricle's wall and chambers size. Then, the contraction ability of heart also increases. Mostly in response to more filling of blood in ventricular, the internal size of the left ventricle increases.

4.2 Heart Rate

Heart rate is the number of times the heart beats per minute. Studies have shown that the efficiency of the heart can be judged through heart rate both at rest and during exercise. Heart rate is markedly decreased as a result of Physical exercises/training particularly endurance training. After 10-12 weeks of endurance training resting heart rate can come down subsequently from normal 80 to 70 beats/minutes. If you are a healthy individual doing regular systematic aerobic training or exercises, your resting heart rate is decreased. This decreasing heart rate trend shows the improvement of your cardiovascular fitness. Highly conditioned endurance athletes usually have resting heart rate lower than 40 beats/minute and some have even lower than 30 beats/minute.

The heart rate recovery period also decreases as a result of Physical Training (endurance). During exercise our heart rate should increase to meet the need of our active muscles. Normally after finishing the exercises our heart rate does not come down immediately rather it takes some time to return to its resting rate. But due to aerobic physical exercise programme recovery process fastens. Heart rate recovery period is the time, which we take to return heart rate to normal level. In general more fit individuals recover faster after a target rate of work than the less fit individuals.

4.3 Stroke Volume (SV)

The stroke volume is the amount of blood pumped by the left or right ventricle of the heart per beat. As a result of physical exercises/training especially endurance training the stroke volume increases. Stroke volume of untrained individual at rest is about 55-75 ml Whereas stroke volume of trained athletes at rest is 80-90 ml and in highly trained athletes it is about 100-120 ml at rest.

In a trained athlete, the left ventricle of heart holds more blood during relaxed state than it does in an untrained athlete's heart. It means more blood is available to enter the ventricle, which ultimately increases stroke volume. In trained individual the amount of blood pumped is more in one beat as compared to untrained which also results decrease in heart rate of trained individual.

4.4 Cardiac Output

The cardiac output is the amount of blood pumped in one minute by either the left or right ventricle of the heart.

Cardiac-output = Stroke Volume x Heart Rate

We have discussed the effects of physical exercise/training on heart rate and stroke volume which are the components of cardiac output. The cardiac output at rest remains unchanged but at maximal levels of exercise it increases considerably. This increase results mainly from the increase in maximal stroke volume. Maximal cardiac output ranges from 14 to 20 L/min in untrained individual, 25 to 35 L/min in trained individual and 40 L/min or more in highly endurance trained athletes.

4.5 Blood Volume

Physical training/exercises particularly endurance results increase in blood volume which is mainly due to increase in blood plasma volume (liquid portion of the blood). Number of red blood cell (the cells in the blood which contain hemoglobin and carrying oxygen) also increases. Increased blood plasma volume decreases blood thickness that can improve circulation of blood and oxygen availability. Highly trained male athletes may have more than 7 liters of total blood volume as compared to untrained individual having less than 5.6 liters of total blood volume.

4.6 Blood Flow

Physical training changes the function and structure of heart. It is well known fact that active muscles require more oxygen and nutrients. To fulfill these requirements, more blood must be supplied to these muscles during exercises. As the muscles become better trained, the circulatory system adopts to increase blood flow to them. The blood supply is increased to the muscles due to the following reasons or factors:

- Increased blood volume.
- Increased in capillaries of trained muscles.
- Good opening of present capillaries in trained muscles.
- Good and more effective redistribution of blood.

Physical exercises especially aerobic or endurance training increases blood flow to muscles.

4.7 Blood Pressure

The blood pressure is the driving force that moves blood through the circulatory system. Systolic pressure (the higher pressure) is reached when blood is put (ejected) into the arteries whereas diastolic pressure (the lower pressure) is reached when the blood drains from the arteries.

Due to physical exercises/training particularly endurance/aerobic training arterial blood pressure changes very little during maximal workout. But resting blood pressure is lowered in individuals who are having high blood pressure. This reduction takes place in both systolic (higher) and diastolic (lower) blood pressures.

4.8 Summary of Effects of Physical Training on Circulatory System

Physical exercises / training particularly endurance or aerobic training causes the following changes in the parameters of circulatory system:

- Internal size of the left ventricle increases.
- The contraction ability or strength of the heart increases.
- Resting heart rate decreases considerably.
- Maximum heart rate, either remains unchanged or decreases slightly.
- The heart rate recovery period decreases.
- Stroke volume increases during rest, and sub or maximal exercises.
- No change in Cardiac output at rest.
- Considerable increase in Cardiac output at maximal level of exercises.
- Blood volume increases as a result of increase in plasma volume and RBC counts.
- Blood viscosity (thickness) decreases resulting good circulation and oxygen availability.
- Blood flow to muscles increases due to more blood volume, effective blood redistribution and increased capillarization.
- Reduction in resting blood pressure (both systolic and diastolic).

5. Conclusion

It is concluded that regular exercise is an important part of a healthy lifestyle. People who lead an active life are more likely to live longer. Physical activity can ease the symptoms of certain long-term health conditions, such as rheumatoid arthritis and chronic obstructive pulmonary disorder. Exercise not only improves your physical health, it also helps to reduce anxiety and lowers your risk of other mental health conditions.

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