

OVERVIEW of Exercise physiology, performance analysis and training.

**How do I prepare to perform on the international stage?
(AO3)**



A. Overview Short term effects of exercise on the cardiovascular system

- There are two circulatory systems; pulmonary and systemic, their functions are transportation and removal of nutrients, oxygen, carbon dioxide and waste products.
- The cardiac cycle consists of two phases, diastole (relaxation phase) and systole (contraction phase).
- One cardiac cycle (heart beat) takes on average 0.8seconds.
- Venous return is the volume of blood returning back to the heart, it is supported by valves and smooth muscle in the veins, musculo-skeletal pump and pressure gradients.
- Starling's Law refers to the increased stroke volume, due to increased filling of the heart.
- Cardiac values at rest and at different intensities, the relationship between Cardiac Output, Heart rate and Stroke Volume ($Q=HR \times SV$).
- At rest $Q=5$ l/min compared with up to 35 l/min when exercising.
- The bodies transport system consists of arteries, veins, and capillaries that vasodilate or constricts to maintain increase or decrease blood pressure.
- Blood pressure at rest 120/80mmHg. It tends to be the systolic pressure that increases significantly compared with the diastolic. Aerobic exercise increases blood pressure to 180/85mmHg whereas strength training can increase both up to 240/160mmHg.
- It is important to note that aerobic exercise causes the lowest increases to blood pressure and are therefore the safest for those with cardiac problems.
- Control of heart rate is carried out in the Cardiac Control Centre (CCC) found in the Medulla Oblongata of the brain; this is part of the Autonomic Nervous System (ANS). The (ANS) has two sub-divisions, the Sympathetic Nervous System (SNS) and the Parasympathetic Nervous System (PNS).
- When our bodies are at rest the parasympathetic nervous system is in control of

the heart rate compared with the sympathetic nervous system when exercising.

- The cardiac control centre (CCC) has three ways of regulating or controlling heart rate; neural (various receptors), hormonal (adrenaline/noradrenaline), intrinsic I (Starling's Law).
- Redistribution of blood to muscles during exercise (blood shunting) is caused by vasomotor control.

B. Overview Short term effects of exercise on the cardiorespiratory system

- Two of the major functions of the respiratory system are to:
 - Provide oxygen (O₂) to the working muscles
 - Remove carbon dioxide (CO₂) from the body
- Mechanics of breathing influenced by the diaphragm and intercostal muscles.
- The main function of the respiratory system is gaseous exchange. This refers to the process of Oxygen and Carbon Dioxide moving between the lungs and blood (between the alveoli and capillaries).
- This occurs because of the process of diffusion. Diffusion occurs when molecules move from an area of high concentration to an area of low concentration until equilibrium is reached.
- The rate of inspiration and expiration is controlled by the respiratory control centre (RCC) found within the medulla oblongata in the brain.
- The respiratory values vary depending upon intensity and duration of exercise.
- $ME = TV \times Bf$
- As with the control of heart rate, breathing rate is controlled by:
 - Chemoreceptors (detect chemical changes)
 - Proprioceptors (detect movement)
 - Thermoreceptors (detect temperature change).

C. Overview long term adaptations of exercise on the cardiovascular system

After a period of prolonged aerobic training (up to 18 weeks) adaptations to the bodies system include: -

- **Musculo-skeletal;** mobility at joints, increased bone density, muscular hypertrophy, efficiency of muscle fibre types, increased force and length of contractions and capillarisation, increases in myoglobin and mitochondria in the muscle cell.
- **Cardiorespiratory;** changes to resting values of Bf, TV, diffusion rates, capillarisation. and haemoglobin content. Values of ME and diffusion when exercising.
- **Cardiovascular;** changes to resting values of SV, HR, BP, (bradycardia, hypertrophy) compared with the changes when exercising,
- Increased **elasticity (vasomotor control) of arteries and arterioles** (allows greater volume of oxygenated blood to pass through the vessels).
- Increased **CP** and **glycogen** stores and increased **tolerance to lactic acid.**
- Increased capacity of the training zones and energy systems.
- Higher VO_2 max and an increase in anaerobic threshold.

D. Overview of diet nutrition and supplementation

- The primary source of energy for their training and competing regimes would come from carbohydrate.
- Carbohydrate are generally the main source of energy fuelling exercise of a moderate to high intensity, with fat providing energy during exercise that occurs at a lower intensity.
- The glycaemic index is the rate at which carbohydrate releases energy (glucose) into the bloodstream.
- Carbo-loading is a diet or process of increasing carbohydrate consumption and storage of glycogen usually prior to an endurance event.
- There tends to be three stages to carbo-loading; depletion, tapering, loading.
- Sports supplementation is also called **ergogenic aids**.
- The most common supplements of protein, caffeine and creatine all have different effects on the body.
- Proteins are required for growth and repair.
- Caffeine's main physiological impact is the maintenance of alertness in the brain.
- Sports people who take creatine do so to improve strength, however there are no long term studies to look at the physiological impact of the supplementation.
- Doping means athletes taking illegal substances to improve their performances.
- The most commonly used substances are androgenic agents such as anabolic steroids.
- Human growth hormone can promote weight loss and increase muscle size.
- Blood doping is the misuse of certain techniques and/or substances to increase one's red blood cell mass, therefore increasing stamina and performance.
- Erythropoietin (EPO) is the most common synthetic oxygen carrier.

E. Overview of Biomechanical principles

- Newton's three laws of motion:
- Newton's 1st Law: A body continues in its state of rest or motion in a straight line unless acted upon by an external force.
- Newton's 2nd Law: The rate of change of momentum of a body is directly proportional to the force causing it and the change takes place in the direction in which the force acts.
- Newton's 3rd Law: To every action there is an equal and opposite reaction.
- Momentum allows us to understand how mass and velocity influence the movement of athletes.
- Impulse allows us to explain how force and time can cause the athlete to start moving or change direction.
- Force time graphs are often used to demonstrate impulse.
- Balance and stability can be understood through knowledge of a person's centre of mass.
- Stability is increased by making the base larger and lowering the centre of mass.
- Linear motion allows us to understand how quickly the athlete or object is travelling and in which direction. $SPEED = DISTANCE/TIME$.
- Angular motion relates to rotating movements at joints. A cyclist will produce angular movement at the legs pushing the pedals to achieve linear motion.
- Moment of Inertia is the body's resistance to motion.
- A projectile is any object or body that is in flight. The flight path (trajectory) of the object is influenced by gravity and air resistance.
- There are three key factors that determine the path of the projectile: Angle, Height and Velocity of the projection.
- The Bernoulli principle refers to changes in fluid (water and air) speeds due to changes in pressure.
- Magnus Effect - this is the Bernoulli principle applied to spinning objects. The side of the object spinning in the direction of the air will result in a high velocity air

flow and therefore low pressure.

- Fluid mechanics looks at the movement through air and liquid, applying the principles of increasing and decreasing, drag through streamlining and altering laminar flow.

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