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Chronic Physiological Adaptations to Exercise

It is known that regular exercise can lead to long term physiological adaptations, though regular exercise the body will see improvements in many aspects this includes improvements to the cardiovascular system, Respiratory system, the muscular system, and skeletal system (Patel, 2024). The body's metabolic system will also have significant improvement though regular exercise (Thyfaut, 2020). This essay will be exploring how the body responses to exercise and how the body reacts to different exercise intensity's, durations and mode thus seeking out how, though exercise can this improve many functions in the body.

Aerobic exercise when performed for prolonged periods of time have a profound effect on monocellular and microscopic levels (Farrell, 2023). This will profoundly impact the cardiovascular and musculoskeletal systems the two main affected systems (Farrell, 2023). This will enable more efficient oxygen delivery, endurance, and overall performance. 70- 80% of oxygen delivered during exercise will be extracted to the active muscle (Korthuis, 2011). This shows there is a reserve of oxygen in the blood that can be utilized to meet the needs of the active muscle (Korthuis, 2011). This means that with improved oxygen delivery there is an increase in red blood cells, better energy production, delayed fatigue, improved recovery, improved cardiovascular efficiency and enhanced strength performance (Badenes-Bonet, 2021). To improve oxygen delivery regular aerobic exercise is best such as, walking jogging, swimming, or cycling all of these exercises consider a subnational amount of breathing, thus enhance more efficient oxygen delivery (Ehlken, 2015).

Through acute exercise the body will see adaptations in the heart rate and stroke volume, but this is only through short periods. When during exercise the heart rate will rise quickly but will return to a resting state (Farrell, 2023). Through chronic exercise there will be a permanent changed in cardio hypertrophy, there are two types of hypertrophies one physiological and the other pathological, physiological occurs in response to normal stimuli growth whereas pathological can result in hypertension (Frenandes, 2015). Physiological hypertrophy is where the heart muscle mass increases this is a normal adaptation to the increased workload to the heart when exercise is performed on a regular basis (Fernandes, 2015). There are also changes to the heart rate which means that the heart does not have to beat as often for blood to circulate around the body, thus meaning a lower resting heart rate (Farrell, 2023). The effects of stroke volume during chronic exercise are when the muscle of the wall of the left ventricle of the heart thickens thus meaning the heart can pump more blood through the body during each contraction of the heart muscle thus meaning better stroke volume (Lee, 2016). This means the body does not have to work as hard to move blood efficiently around the body (Lee,2016). Improvements in circulation will happen, blood vessels become more flexible thus

reducing blood pressure, improved cardiovascular function, increased oxygen consumption, and improved flow to the skeletal and cardiac muscle (Green, 2018).

Long term aerobic exercise can lead to better mitochondrial function (Huertas, 2019). Mitochondria is a membrane cell that is often referred to the “powerhouse cell”, they are a part of the oxidative phosphorylation system and are located in the mitochondrial cristae (Huertas, 2019). This is composed of complex electron transport chains and ATP synthase (Huertas, 2019) and can generate the energy needed for cellular function and breaks down molecules which converts to an energy source called ATP and enhances calcium signalling (Huertas, 2019). The importance of its function is to provide energy to most cells in the body, it also improves cellular respiration this helps the breakdown of glucose to produce energy (Huertas, 2019). Through exercise the mitochondrial biogenesis changes the respiratory system in a positive way, with increased mitochondria production the skeletal muscle function can improve (Huertas, 2019).

Ensuring this to one's lifestyle can make for a higher VO₂ max, VO₂ max measures cardiorespiratory fitness (Ross, 2016). Studies have proven there is a strong correlation between higher VO₂, and longevity one study showed that for every 1ml/kg increase in VO₂ max there was a 10% decrease in mortality (Ross, 2016). This can reduce the risk of type 2 diabetes by 30% (Ross 2016; Thyfault, 2021). Through the life span VO₂ max starts to decline around the age of 25 (Strasser, 2018). However, there is evidence that shows it is possible to maintain or even improve VO₂ max even in older population (Strasser, 2018). Engaging in regular aerobic activity will enhance this, considerations to interval training is advised with alternating between high intensity and low intensity training periods (Strasser, 2018). International cardiology guidelines recommend a minimum of 150 minutes per week of moderate intensity or 75 minutes of vigorous intensity of aerobic exercise per week (Mannakkara, 2023).

The two main organs systems that are responsible for energy production and homeostasis are the nervous system and the endocrine system this is associated with the metabolic effects of the whole body and systemic health effects (Thyfault, 2020). There is plenty of evidence that Chronic exercise will exert many benefits to the metabolic system and in many functions which includes the endocrine system, the body will see changes in cellular growth and repair (Patel, 2024). Testosterone levels will increase and the bodies response to insulin sensitivity will also increase, allowing the muscles to be more responsive to insulin (Patel, 2024). Exercise's such as jogging cycling and resistance training improves insulin sensitivity, by doing at least 150 minutes a week to moderate to vigorous aerobic exercise will change the bodies functioning in a positive way (Kirwan, 2018). This will allow a better glucose uptake from the bloodstream and can reduce the risk of type 2 diabetes (Patel, 2024). Studies found that through chronic

exercise, changes in the plasma lipid profile will happen and this will increase High-density lipoprotein cholesterol (HDL-C) good cholesterol and decrease Low-density lipids (LDL) which is bad cholesterol this can reduce the risk of Coronary heart disease (Wang, 2017; Nystoriak, 2018). Though chronic exercise fat oxidation will increase, and the body will become more efficient at burning fat, thus leading to weight loss (Thyfault, 2020).

Through chronic exercise the nervous system will also go through adaptations, the pituitary gland which is located in the brain will release a growth hormone in response to prolonged training, thus enhances bone and tissue growth (Patel, 2024). The systematic benefits of chronic exercise and the relation to brain health has positive effects on the hippocampus (Vecchio, 2018). The hippocampus is associated with memory and learning (Vecchio, 2018). Through exercise it can increase the volume and enhances neurogenesis, this could potentially improve cognitive function (Vecchio, 2018). This also has benefits to the blood-brain barrier and proteins of the blood-brain barrier which protects the brain from circulating molecules this could have benefits in reducing toxicity levels, stress, inflammation and, enhance insulin transport this can lower the risk of Alzheimer's and enhance longevity (Vecchio, 2018; Brown et al, 2022). Regular aerobic activity will help towards brain health, with activities such as walking, jogging, and more mindful exercise such as yoga (Gomes-Osman, 2018).

Physical Activity and Health across the Lifespan

Evidence suggests that regular exercise across the life span in particular aerobic fitness indicates resilience in many functions of the body as well as long term health benefits and a decreased risk to chronic diseases (Roychowdhury, 2020). Promoting physical activity to enhance well-being and longevity is based on solid, scientific evidence and is important throughout a person's life span (Roychowdhury, 2020). As modern-day lifestyle has become more sedentary it is important to remember that the adaptations of the human body do not respond well to sedentary behaviour as human ancestors came from hunter-gatherers and had no choice but to be active and to this day the biological functions have relevantly remained the same however, life style has become very different through living a more sedentary life style can impact on well-being (Alt, 2022). Prolonged exercise will have physiological benefits, however, there are also psychological benefits. Exercise serves as a great buffer against stress, thus decreasing symptoms of anxiety and depression (Roychowdhury, 2020).

When physical activity is performed, there will be a release of endorphins to the brain this is a chemical reaction that happens to the brain when a person undergoes physical activity, endorphins are known as the "feel good hormone" (Schoenfeld, 2021). It is realised by the pituitary gland and the hypothalamus and can help reduce anxiety and depression (Schoenfeld, 2021). However, this can lead to overtraining, overtraining can lead to negative effects to the body which can result in feeling fatigue, trouble sleeping

and hormonal imbalances, finding balance between exercise and rest is important (Brenner, 2024). Overall brain health is improved with better cognitive function, through prolonged exercise can limit or prevent the risk of diseases such as Alzheimer's and dementia (Mandolesi, 2018). Neuroplasticity is a protein that enhances brain cell growth and strengthens the connection between neurons which enhances better cognitive function (Mandolesi, 2018). Chronic physical activity can protect against inflammatory-related diseases by optimizing physiological, neuroendocrine stress and reducing visceral fat (Cerqueira, 2020). Thus, enhancing anti-inflammatory, neuroplasticity, and enhance growth factor expressions (Cerqueira, 2020). With all these factors the biological mechanisms create efficient activation and a positive recovery and communication among the stress responsive system (Faenza, 2020).

Through long term physical activity this can increase bone growth and can delay the skeletal bone from ageing, bone ageing is associated with osteoporosis (Feinza, 2020). Bone ageing is determinate by oxidative stress thus, through an active lifestyle this can limit the risk of developing bone ageing, through exercise this can help maintain bone density, resistance training is an excellent way to maintain bone health (Feinza, 2020). It will also maintain muscle mass the two combined is essential for mobility and independence (Distefano, 2018). There must be a continuous process of skeletal muscle turn over this is the process of muscle breaking down and re-building, this is so proteins are being replaced to maintain muscle function and can repair. (Ferreira, 2023). This is done through exercise with strength training in favour. It is highly important to ensure the muscle can function properly and can repair damaged proteins and remove difunctional proteins (Ferreira et al, 2023). This is especially important for the older population as the risk of falls decreases. Falls are a leading cause of death in the older population and mortality rate increases by 86% among adults aged 65 and older if a fall may occur according to US studies (Lozada, 2023).

Prolong physical activity will improve cardiovascular health as it strengthens the heart thus improving better blood flow, will lower blood pressure and improves cholesterol levels this can reduce the risks of heart disease, stroke and heart failure (Kubota, 2018). Studies have shown that regular exercise can increase life expectancy (Kubota, 2018). Through the effects of chronic exercise, it can have a profound benefit to health and reduced risk of diseases such as heart disease (Lee, 2016). Studies from the British journal of sports and medicine found that if all individuals kept with the recommendations of staying physically active a person's lifespan can increase and just through walking alone people over the age of 40 could live an extra 5.3 years to their life (Veerman, 2025).

Conclusion

Exercising is beneficial to all body systems and to improving cardiovascular health, studies have shown that by within keeping to recommended guidelines that one's overall health can improve significantly. Improvements are seen internally and externally with better heart function increased bone density, better muscle mass, improved cellular function and better brain health. All these beneficial improvements combined can increase a person's life span. Physical activity can reduce major mortality risk factors in diseases as many studies have shown that physical activity can increase a person's life span and additionally add 6.7 years to a person's life according to the British journal of sports and medicine (Veerman, 2025). Staying active throughout life is highly important through childhood to old age as it helps all vital organs function efficiently and helps reduce risks of diseases and provide independence and mobility for people.

Without exercise the body systems and the heart will not perform to their optimum potential and as the systems become weaker it can lead to serious illness. This is highlighted by the incidence of cardiovascular disease and diabetes, in Wales and England alone stats show that between 2023/ 24, 3.5 million people have been diagnosed with type 2 diabetes (Statista, 2024). And according to the World health organisation 17.9 million people died globally from cardiovascular disease (2021) the main cause for these diseases is through a lack of exercise and poor diet this is why it is so important to maintain the recommended guidelines to reduce the risks of such diseases. However, despite the many benefits exercising regularly may have to the body, there are potential risks if a person overtrains, this is called overtraining syndrome. This can cause disruption in the endocrine, neurologic, cardiovascular, and psychological system. A person might experience decreased performance, fatigue, hormonal imbalances, and may elevate cortisol, and reduce testosterone. This is why it is important to implement rest days during training sessions for the body to fully recover.

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