THE BENEFITS OF EXERCISE

Suggesting relevant lifestyle changes to clients is a necessary part of being a Nutritional Therapist and finding ways to encourage clients to live a more active lifestyle is often high on the agenda. ***Fleur Borrelli*** *explains why and how exercise improves health…*

Thanks to advancements in technology, particularly in the last two hundred years, we do not have to live the physically gruelling lives of our ancestors. However, with this modern lifestyle and lack of exercise we are becoming sick, obese and sedentary. In 2004 Professor Booth from the University of Missouri suggested that Sedentary Death Syndrome was a major public health burden and the cause of many chronic diseases[1]. In 2010 the World Health Organization (WHO) estimated that physical inactivity worldwide is responsible for 25 per cent of breast cancers and colon cancers, 27 per cent of diabetes cases and 30 per cent of heart disease[2].

HOW MUCH IS ENOUGH?

Physical activity improves overall health and fitness and reduces the risk of chronic disease. But how much and how often should the average person exercise? In 2010 the WHO set out its recommendations to tackle this question[3]. For adults (age 18 to 64), half an hour of vigorous physical activity, five days per week interspersed with some strength training is recommended. In contrast, Dr Loren Cordain, Professor of Exercise Physiology at Colorado State

University suggests that we should replicate the activity pattern of our ancestors in order to optimise gene expression. Men, who were hunter-gatherers, should cover forty kilometres per day, five days per week and women, gather-hunters, seven to eight miles every second day[4]. And to further confuse, a recent study published in the *European Journal of Applied Physiology* has shown that metabolic health and aerobic capacity can be improved by putting in only three minutes of high intensity training per week![5]

STRUCTURAL AND METABOLIC BENEFITS

Exercise has always been prized for its structural and metabolic benefits. Regular training ensures the growth in size and strength of the muscle contractile apparatus. It increases the number of mitochondria, the power houses where energy is converted into forms usable by the cell. Muscles can then be fine-tuned into becoming efficient, fat-burning machines. Blood flow capacity increases, allowing oxygen-rich blood to flow to the extremities and improving the circulatory system[6]. Encouragingly, a recent study in the *Journal of Gerontology* has confirmed that these benefits can be reaped regardless of age[7].

REGULATION OF HUNGER AND APPETITE

Systems which control and regulate hunger and appetite are positively affected by regular physical activity. Leptin and insulin are master hormones when it comes to weight control, by influencing how energy is metabolised in the body. They modulate reward responses by causing the brain to send signals to stop eating. In the case of leptin and insulin resistance, cells are no longer sensitive to increasing amounts being produced. This affects the signalling to the appetite centre in the brain and the likely consequences are an increase in appetite, carbohydrate cravings and inflammatory visceral fat storage.

Hyperinsulinemia was thought to be a result of overeating, a survival strategy allowing us to store fat in times of plenty in case of scarcity[8]. A new hypothesis has now been proposed by evolutionary biologists Watve and Yajnik, suggesting that hyperinsulinemia is a socio-ecological response to modern life. Insulin is important for good brain function and this comes at the cost of muscle activity. Muscles and adipose tissue become insulin-resistant to allow this switch from 'strong' to 'smart' and energy is allocated to the brain for neuronal development[9]. Regular physical activity can help to normalise insulin and leptin sensitivity and even reverse resistance[10,11].

Unlike its counterpart leptin, ghrelin is a fast-acting orexigenic hormone which is produced mainly by endocrine cells lining the fundus of the stomach known as P/D1 cells[12]. The level of ghrelin secretion by the stomach increases before eating and decreases afterwards, suggesting that it acts as an appetite stimulatory signal[13]. It is also believed to be a regulator of appetite during and after exercise[14].

Ghrelin has been shown to regulate the secretion of Human Growth Hormone (HGH) by the pituitary, which is also stimulated by exercise, particularly high intensity training and undisturbed sleep[15]. HGH follows a circadian rhythm and is released in up to 12 pulses per day, with the greatest surge around one hour after the onset of sleep[16]. HGH is important for the turnover of muscle, bone and collagen and regulates fat metabolism[17].

EXERCISE IS ANTI-INFLAMMATORY

Meal frequency, up to six meals per day, has been linked to post-prandial inflammation and a causal factor in insulin-resistance and metabolic syndromes[18]. Exercising in a 'fasting state' (on an empty stomach) has been shown to have all of the health benefits mentioned above[19]. This forces the breakdown of glycogen stores and fat without sacrificing muscle mass which normalises insulin sensitivity, balances ghrelin levels and promotes the release of HGH[20]. Pre-prandial exercise may induce the production of lactoferrin, a multifunctional protein which can prevent post-prandial inflammation[21].

Interleukin 6 is an inflammatory marker produced by macrophages and associated with chronic systemic low grade inflammation. However, during exercise an anti-inflammatory version is produced by muscle fibres, stimulating the appearance of anti-inflammatory cytokines and inhibiting the production of pro-inflammatory ones. In addition, the anti-inflammatory interleukin 6 enhances lipid turnover and stimulates lipolysis and fat oxidation[22]. Scientists from The Copenhagen Muscle Research Centre therefore believe that regular exercise may offer protection against low grade inflammation[23].

Toll-Like Receptor's (TLR's) also play an important part in the mediation of systemic inflammation. TLR's are a class of protein on the surface of antigen-presenting cells of the innate immune system and are responsible for activating immune cell responses. It is thought that during exercise they are down-regulated and this decreases the inflammatory capacity of white blood cells, possibly reducing the risk of chronic disease[24].

More recently, ideas have evolved to suggest that exercise may exert a beneficial effect on inflammatory responses within the central nervous system. Neuro-inflammation can be caused by brain injury, bacterial infection, stress, advanced age and genetic mutations. In a recent study, physical activity reduced inflammation and facilitated recovery after brain injury[25].

IMPROVED STRESS TOLERANCE

Exercise activates stress systems due to an increased energy demand from body tissues and this is a normal physiological reaction. The sympathetic nervous system produces noradrenaline which redistributes energy to the areas that need it most, such as the muscles. The hypothalamus then responds by sending a signal to the pituitary which results in the production of cortisol by the adrenal glands to switch the stress axis off[26]. Regular physical activity produces a change in glucocorticoid receptors in the hypothalamus, making us more sensitive to cortisol and therefore better able to regulate negative stress[27]. Exercise also enhances cognitive function and elevates mood[28].

There are only a few known areas of the adult brain where neurogenesis takes place. The dentate gyrus is a small area in the hippocampus associated with the formation of memories and thought to play a role in depression. It is stimulated by exercise and allows for a greater capacity to control the HPA axis[29]. Brain Derived Neurotrophic Factor (BDNF), promoted through aerobic exercise, also activates brain stem cells which can be converted into new neurons[30]. Whilst there are no human studies available, it is thought that BDNF could be linked to GABA, a calming neurotransmitter which controls the body's excitatory responses.

Heart Rate Variability

There is a constant interplay between our sympathetic and parasympathetic nervous systems. During exercise it is the sympathetic nervous system which comes into focus to regulate neuromuscular and cardio function. The relaxation response is regulated by the parasympathetic nervous system to keep the body in a state of homeostasis. Effective emotional functioning depends on being able to flexibly change our physiological response to the environment. By measuring the variation in the time interval between heart beats, Heart Rate Variability (HRV) provides a picture of this interplay between the two systems and their influence on heart rate[31]. Increased HRV is linked to good health and fitness whereas decreased HRV can be a sign of stress, fatigue or even burn-out.

IMMUNE FUNCTION

Regular moderate exercise not only helps the immune system fight bacteria and viruses, but can also decrease the risk of developing chronic conditions such as heart disease[32]. Exercise increases the number of leukocytes circulating in the blood, consisting mainly of neutrophils and lymphocytes but also natural killer cells of the innate immune system to provide general protection. For this reason, regular moderate exercise, up to two hours per day, is associated with a 29 per cent reduced incidence of infection compared with a sedentary state[33].

CARDIO FACTORS

Hypertension is a risk factor for stroke, myocardial infarction and cardiac insufficiency. A meta-analysis from 2005 confirmed the beneficial effect of endurance training on blood pressure[34]. Endurance capacity also allows for an increase in high-density lipoproteins. A large part of cholesterol is produced in metabolically active cells where there is a need for the transportation of triglycerides for extra energy. It is oxidised low-density lipoprotein that is a useful marker for cardiovascular disease as it can be taken up by foam cells; these cells are derived from macrophages and smooth muscle and can be found in atherosclerotic lesions[35]. This process is inhibited by high-density lipoprotein which also prevents the conversion of low-density lipoprotein into an oxidised form and its subsequent adhesion to the endothelial wall[36].

ANTIOXIDANT DEFENCES

Moderate exercise can help to buffer the effects of free radicals produced by an increase in oxygen consumption. Free radicals may only cause damage to the body when aerobic exercise is too exhaustive. Compelling new research suggests that exercise-induced free radical production promotes insulin sensitivity in humans and antioxidant supplementation may block the beneficial effects[37]. It is believed that as an adaptive response to exercise, our own antioxidant defence systems are naturally up-regulated.

It seems logical to say that too little exercise may be as damaging as too much and that the benefits lie somewhere in the middle. Professor Pruimboom, Scientific Advisor of the Natura Foundation, believes that physical inactivity is not just a risk factor for chronic disease, but it should be considered the cause[38]. However exercising too often and too intensely affects the immune system, causing illness[39]. An alternative training goal might be to aim for moderate and enjoyable physical activity which is accompanied by a high level of parasympathetic activity[40]. ●

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