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A Review on Health Benefits of Exercise

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Abstract

Physical exercise can be defined as anybody activity which enhances or maintains our overall health and physical fitness. The paper discussed classifications of exercise and the health benefits of exercise. The benefits of exercise are too many which affects the entire systems in the body. It is recommended that everybody should take part in organized selected exercises that will help both in longevity of the cells and also the human body performing its functions optimally.

Keywords: Exercise, Health benefits, cardiovascular system, brain, blood cells, immunity

Definition of exercise

Physical exercise can be defined as anybody activity which enhances or maintains our overall health and physical fitness. According to Farlex free medical dictionary, exercise can be defined as a physical activity that is planned, structured, and repeated for the purpose of conditioning any part of the body. People engage in exercise for so many different reasons which include weight loss, pleasure, development of endurance, prevention of heart disease and Type 2 diabetes mellitus and so on. Historically, the profound benefits of exercise have been known since 65BC when Marcus Tullius Cicero stated that it is exercise alone that supports the spirit and keeps the mind vigour.

Classification of exercise

Based on intensity

Exercise can be classified into 3 based on the intensity, namely Vigorous intensity exercise, moderate intensity exercise, and light intensity exercise. According to Farlex free dictionary, vigorous intensity exercise is that exercise that can lead to heavy breathing, sweating, or an increase in the heartbeat rate. Examples of vigorous exercise are fast swimming, football, jogging, and skipping ropes. Moderate intensity exercise according to the public health experts is defined as any physical activity that burns about 3.5 to 7 calories per minute. Examples include water aerobics, biking on level ground, brisk walking. Light intensity exercise includes walking, stretching, sleeping, sit-ups, dancing, push ups against the wall. It actually consists of those day to day activities that we engage in from time to time (*O'Connor, 2005).*

Based on its effects

Based on the above named criteria, exercise can be classified into aerobic exercise, flexibility exercise and resistance exercise. Aerobic exercise or cardiovascular exercise usually makes use of large muscle groups and makes the body to utilise more oxygen than it normally uses while at rest. Aerobic exercise is most beneficial to the heart and increases the cardiovascular endurance. Examples of aerobic exercise include bicycling, jogging, skipping ropes, brisk walking, and swimming. Flexibility exercise improves the range of motion that reduces the chances of injury (*O'Connor,*

2005). This form of exercise improves the muscle and joint flexibility by stretching and lengthening the muscles and the joints. Resistance exercise which is also known as strength training is performed to strengthen and tone up the muscles. It increases the muscle strength by putting more strain on the muscle than the muscle is usually used to. Examples of resistance exercise are weight lifting, biceps curl using dumbbells, and even push-ups. Resistance or strengthening exercise can be subdivided into 3, namely isometric exercise, isotonic exercise, and iso-kinetic exercise. Isometric exercise involves contraction of muscles without movement of the joints. It is usually performed against an immovable object. A good example of an isometric exercise is pushing your hand against a wall. This form of exercise is usually used for rehabilitation because the exact area of muscle weakness can be isolated. Isotonic exercise is a form of resistance exercise that involves movement of the muscles and joints as the muscle contracts. Example is weight training that involves the use of dumbbells. Iso-kinetic exercise involves the use of machines that controls the speed of contraction. The machine provides muscular overload at a constant speed while the muscle mobilises its force through the range of the motion.

All the various forms of exercise are performed depending on the desired effect on the body and it has been proven that exercise is very important for maintenance of health and wellbeing. However it is important to consider the intensity of the exercise so as not to cause harm than good to the body because engaging in vigorous exercise over a long period of time could lead to release of stress hormones.

Health benefits of exercise

Exercise and the cardiovascular system

The heart is the organ of the body that is responsible for pumping of blood that is utilised by the many cells and tissues in the body. There is a direct relation that exists between cardiovascular mortality and physical inactivity and physical inactivity has been identified as an independent risk factor to the development of heart diseases. Heart diseases are usually as a result of blockages in the arterial inner walls which lead to a reduction in the blood flow to and from the heart. The reduction in the blood flow to the heart as a result of blockages in the blood vessels increases greatly the risk of heart attack. Blockages in the arterial walls are mainly due to accumulation or build up of plaque, which is an accumulation of fat, cholesterol and other substances (*National heart, lung and Blood institute, 2006).*

Sedentary individuals are at a higher risk of developing heart diseases than those who exercise, however the greatest potential for the reduced mortality is in sedentary individuals who become moderately active. The most beneficial effect of the heart on the cardiovascular system can be attained through moderate intensity exercise which induces 40%-60% of maximal oxygen uptake depending on age.

Exercise and the immune system

Exercise has both positive and negative effects on the immune system function and susceptibility to infections. It has been reported that regular performance of 2hour moderate exercise everyday is associated with 29% decrease in susceptibility to upper respiratory tract infection when compared with sedentary individuals (*Freedson et al., 2002).* There is substantial increase in the number of circulating white blood cells particularly lymphocytes and neutrophils and the rate at which it increases depends on the intensity and duration of exercise. Studies have shown that various immune cell functions are temporarily impaired after acute bouts of prolonged continuous heavy exercise (*Pederson et al., 2012).* During or after exercise, there is an increase in the plasma concentrations of substances such as C-reactive protein, anti inflammatory cytokines (interleukin-6, interleukin-10, and interleukin-1-receptor antagonist), tumour necrosis factor-alpha and macrophage protein-1. Interleukin-6 is released from contracting muscle cells and the increase that is observed during exercise is as a result of release of this cytokine from the contracting muscle cells (*Steensberg et al., 2001*).

Hormonal changes also occur in response to exercise, including increases in the plasma concentration of several hormones like epinephrine (adrenaline), cortisol, growth hormone, and prolactin which are all known to have immune-modulatory effects. Muscle-derived IL-6 appears to be at least partly responsible for the elevated secretion of cortisol during prolonged exercise. Infusion of recombinant human IL- 6 into resting humans to mimic the exercise-induced plasma levels of IL-6 increases plasma cortisol in a similar manner (Steensberg et al., 2003). Recent researches have shown that relatively small increases in plasma levels of IL-6 induce the two anti-inflammatory

cytokines IL-1ra and IL-10, together with c reactive proteins and as exercise ensues, the increase in IL-6 precedes the increase in these two cytokines, arguing circumstantially for muscle-derived IL-6 to be the initiator of this response (*Steensberg et al., 2003*). Whether humoral or cell-mediated immunity will dominate depends largely on the type of cytokines that are released by the activated T helper cells. T lymphocytes can be classed as type 1 or type 2 cells, depending on which cytokines they predominantly produce. Type 1 T cells produce mainly Interferon-γ and tumor necrosis factor, and their actions activate macrophages and induce killer mechanisms, including T-cytotoxic cells, thereby driving the immune system toward cell-mediated immune responses, which primarily provide protection against viruses. Type 2 cells mainly produce IL-4, IL-5, IL-10, and IL-13, which are necessary for promotion of humoral immunity, IgE-mediated allergic reactions, and activation of potentially tissue damaging eosinophils. IL-4 and IL-13 are responsible for B-cell differentiation that results in antibody production, while IL-5 stimulates and primes eosinophils. Together with IL-4, IL-10 (which is also produced by monocytes and B cells) can inhibit type 1 T-cell cytokine production. Interestingly, it appears that exercise can influence the type 1/type 2 cytokine balance. Strenuous exercises or prolonged bouts of moderate intensity exercise inhibits the production of Interleukin-6 (*Starkie el al., 2001*), and also inhibits the Interleukin-2 and Interferon-gamma by the T-lymphocytes (*Halson and Jeukendrup, 2004).*

Effect of exercise on the brain function

Consistent aerobic exercise over a period of several months induces an increase in increased gray matter volume in multiple brain regions, particularly those which give rise to cognitive control. The brain structures that show the greatest improvements in gray matter volume in response to aerobic exercise are the prefrontal cortex and hippocampus (Erickson et al., 2014).

Neurobiological effects

The wide range of neurological effects that exercise has on the body could be long term and short term. Some examples of these exercises include jogging, brisk walking, cycling and swimming. Several researches that have been carried out have shown that consistent aerobic exercise (example walking for 30 minutes daily) induces persistent beneficial and neural plasticity as well as healthy alterations in gene expression. Neural plasticity is the ability to adapt overtime in response to stimuli (*Malenka el al., 2009*).

Long term effects of exercise are increased neurogenesis, increased neurological activity (c-Fos and BDNF signalling), improved stress coping, enhanced cognitive behavioural control, and structural and functional improvements in brain structures & pathways associated with control and memory. Exercise improves neurogenesis by increasing the production of neurotrophic factors (compounds that promotes survival and growth of neurons) that includes brain derived neurotrophic factor (BDNF), insulin- like growth factor (IGF), and vascular endothelial growth factor (*Szuhany et al., 2014*).

Another long term effect of exercise is that it helps in fighting depression. Depression is a mood disorder that is characterised by severe feeling of dejection and in most cases those that suffer from depression end up committing suicide. A number of medical reviews have shown that exercise has a significant and persistent antidepressant effect in humans (*Cooney et al., 2013*). The antidepressant effect of exercise is believed to be mediated through increased brain derived neurotrophic factor (BDNF) signalling in the brain. In 2013, Cochrane collaboration review on physical exercise noted that exercise is more effective in control intervention and comparable with psychological or antidepressant drug therapy.

The major short term effect of exercise is euphoria, which is colloquially known as “runner’s high” in distance running or “rower’s high” in crew (*Raichlen et al., 2012).* Recent researches and medical reviews have shown that endogenous euphoriants such as beta-phenylamide (stimulant), beta-endorphin (an opiod), and anandamide are responsible for producing exercise related euphoria. Beta-phenylamide also known as phenylethylamine is a potent endogenous trace amine neuromodulator that has the same bimolecular target as amphetamine and as a result they interact with monoamine neurons in the central nervous system in the same manner. Thirty (30) minutes of moderate to high intensity exercise has been shown to induce a significant increase in beta-phenylacetic acid. Beta-endorphin is an endogenous opiod neuropeptide that binds to opiod receptors to produce pain relief and euphoria. Moderate intensity exercise produces the greatest increase in secretion of beta-endorphin synthesis whereas higher or lower intensity exercises are associated with smaller

increases in beta-endorphin synthesis. Anandamide is an endogenous cannabinoid neurotransmitter that binds to cannabinoid receptors (*Tantimonaco et al., 2014*). Aerobic exercise causes an increase in the plasma anandamide level and it has been observed that moderate intensity exercise causes the greatest increase in plasma anandamide concentration. Increased plasma anandamide concentration is associated with psychoactive effects because it can cross the blood-brain barrier to act on the central nervous system (*Tantimonaco et al., 2014*).

Other effects of exercise on brain function

Exercise can reduce the risk of developing dementia, and in the Caerphilly heart disease study which over the course of 30 years observed 30 male subjects to determine the association between exercise and dementia. It was shown that male subjects who exercise regularly showed a 59% reduction in dementia when compared with sedentary individuals (*Elwood et al., 2013*).

Effect of exercise on sleep

A review of published scientific research showed that exercise helps in sleep disorders like insomnia. It was observed that exercise induced effects on sleep was obtained when exercise was done 4-8 hours before bedtime, whereas heavy exercises before bed time was detrimental (*Buman and King 2010*).

Anti-cancer effects of exercise

Physical activity (exercise) has been shown to have a relationship with reduced cancer mortality, especially in breast cancer and colon cancer mortality (*Friedenreich et al., 2012*). Hyper-methylation of CACNA2D3 and L3MBTL genes is associated with development of gastric cancer and breast cancer, brain tumors respectively (*Yuasa et al., 2009; Zeng et al., 2012*). Physical activity or exercise results in low methylation of these genes thereby leading to a decrease in mortality. Cancer cachexia is a multi-organ syndrome characterised by inflammation, weight loss, muscle and adipose tissue wasting in cancer patients(Evans et al.,2008) and exercise is widely accepted as a non-pharmacological intervention for the prevention or attenuation of cancer cachexia in cancer patients (*Lira et al., 2014).*

Exercise and type 2 diabetes mellitus

Physical inactivity and muscle disuse results in accumulation of visceral adipose tissues and loss of muscle mass consequently leading to activation of a network of inflammatory pathways that promote insulin resistance or impair the function of insulin. It was discovered that active muscle cells produce myokines whereas physical inactivity or muscle disuse leads to an impaired myokine response or resistance to the effects of myokines, thereby explaining the reason why lack of exercise increase the risk of developing diseases such as Type 2 diabetes mellitus and other cardiovascular diseases (*Pederson, 2012*).

Effect of exercise on the blood cells

Red blood cells

The main function of red blood cells in exercise is the transport of O_2 from the lungs to the tissues and the delivery of metabolically produced CO2 to the lungs for expiration. Haemoglobin also contributes to the blood's buffering capacity, and ATP and NO released from red blood cells helps to vasodilation and improved blood flow to working muscle and these functions require adequate amounts of red blood cells in circulation. Trained athletes, especially those that engage in endurance sports such as marathon races and other long distance races, have a decreased haematocrit, which is sometimes called "sports induced anaemia." This is not anaemia in a clinical sense, because these athletes in fact have an increased total mass of red blood cells and haemoglobin in circulation relative to sedentary individuals. The slight decrease in haematocrit by training is brought about by an increased plasma volume (PV) (Obeagu *et al.2016).*

Even though exercise stimulates erythropoiesis, it can decrease the red blood cell mass by intravascular haemolysis of senescent red blood cells, due to mechanical rupture of red blood cells as they pass through capillaries in contracting muscles, and by compression of red cells e.g., in foot soles during running or in hand palms in weightlifters. These adjustments cause a decrease in the average age of the population of circulating red blood cells in trained athletes and production of newer red cells. These younger red cells are characterized by improved oxygen release and deformability, both of which also improve tissue oxygen supply during exercise (*Mairbaurl, 2013*).

White blood cells

White blood cells are referred to as the soldiers of the body and serve as the body's main defence system against infections. When a microbe or abnormal cell enters the body, the white blood cells move to the area and fight the microbe or foreign material. But if initially the microbe fights back, the white blood cells increase drastically in number so as to overcome the challenge. During exercise, blood circulation through the body is faster than normal and as the blood moves white blood cells, oxygen and nutrients pass through the walls of capillaries into the interstitial fluid or tissue fluid whereas cell waste flows in the opposite direction into the circulation for excretion (*Sheehan, 2015).*Moderate increase in the number of lymphocytes (lymphocytosis) is observed after a few minutes of acute bouts of exercise which may often lead to an increase in the total white blood cell count (*Bhatti, 2003*). However some forms of exercise that require the same amount of movement over a period of time focuses on specific muscles and results in improper circulation of blood to other organs and tissues in the body. These areas then become deficient in white blood cells, oxygen and nutrients. Low or moderate intensity exercise that requires the same type of movement over a long duration of time can cause improper circulation and lower white blood cell counts (*Sheehan, 2015*).

Harmful effects of excessive

Routine exercise is important to the body and from its numerous health benefits we can confidently say that it helps in the prevention and treatment of many cardiovascular diseases and other ailments. Just like the old saying that too much of everything is bad, excessive exercise is known to be more harmful than good. The harmful effects of exercise are usually experienced when the duration of a moderate or low intensity exercise is prolonged or after endurance training such as marathon and triathlon. Excessive exercise often strains the ligaments and tendons thereby increasing the risks of bone fractures and injuries. Also the immune system is weakened if exercise is done excessively leading to the increased risk or susceptibility to a wide range of infections. This could be observed in Over Training Syndrome (OTS) where the immune system is suppressed due to overtraining leading to increased incidence of upper respiratory tract infections associated with excessive exercises like marathon *(Smith, 2003).*

Too much of exercise could lead to so many cardiovascular problems. It could lead to circulation problems like stroke (*Alexander, 1998*). Excessive exercise such as endurance training causes acute dysfunction of the right ventricle resulting in chronic structural changes and reduced right ventricle function (*La Gerche, 2011*).

Conclusion

Physical exercise can be defined as anybody activity which enhances or maintains our overall health and physical fitness. There is a direct relation that exists between cardiovascular mortality and physical inactivity and physical inactivity has been identified as an independent risk factor to the development of heart diseases. Sedentary individuals are at a higher risk of developing heart diseases than those who exercise, however the greatest potential for the reduced mortality is in sedentary individuals who become moderately active. Exercise has both positive and negative effects on the immune system function and susceptibility to infections. During or after exercise, there is an increase in the plasma concentrations of substances such as C-reactive protein, anti inflammatory cytokines, tumour necrosis factor-alpha and macrophage protein-1. Hormonal changes also occur in response to exercise, including increases in the plasma concentration of several hormones. Consistent aerobic exercise over a period of several months induces an increase in increased gray matter volume in multiple brain regions, particularly those which give rise to cognitive control. Physical activity (exercise) has been shown to have a relationship with reduced cancer mortality, especially in breast cancer and colon cancer mortality.

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