Mini Review

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Exercise, beyond chronic disease prevention-pathways for brain plasticity

Abstract

Physical inactivity and sedentary lifestyle, can be considered as important health-related challenges which can affect public health. Decrease in level of physical activity may increase the risk of chronic diseases including over weight/obesity, diabetes, cardio-vascular disease, cancers and neurodegenerative diseases. Regular physical activity and exercise, regardless the type, intensity, duration and frequency, can bring many health benefits including increase in cardio-respiratory fitness, physical fitness, decrease in risk of chronic diseases and brain health. The purpose of this study, was to assess the effect of exercise on brain health and brain plasticity along with other beneficial effects including weight management and disease prevention and highlight the relation between body organs with emphasize of cardiovascular system and central nervous system.

Keywords: exercise, brain plasticity, cardiovascular system, health

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Introduction

Recent scientific research have been suggested that physical activity and regular exercise, may improve brain function which can be considered as a preventative strategy for neurodegenerative diseases. The underlying mechanism which exercise can affect the brain, it not clear yet, although some evidences have suggested that an ingredient known as clasterin, can increase the effect of exercise on hippocampus, cell production, memory improvement and decrease in inflammation in brain.[1] Physical activity and exercise can affect different regions in brain, especially hippocampus, which may affect memory, learning and neurodegenerative diseases prevention. Endurance exercise such as running, may increase neurogenesis, synaptic plasticity, increase in neutrophin and neurotransmitters level, angiogenesis and decrease in neural inflammation along with increase in hippocampus mass. It has been indicated that during exercise, adipose tissue and liver, produce Exerkin which can help homeostasis, neural function, synaptic and brain plasticity due to increase in blood flow.[2]

Physical exercise- a reverse epigenetic clock

Sedentary lifestyle and physical inactivity are common challenges in industrialized societies which can be a leading cause for cardio-vascular diseases, metabolic impairment, cancer and neurodegenerative diseases. During recent years, regular exercise, regardless to its type, has been introduced as a component of healthy lifestyle, as it can improve physical function, lipid profile and metabolic status beside its beneficial effects on brain.[3,4,5]

How can exercise affect brain plasticity?

Telomers:-Studies on brain and factors which can affect on brain health, have indicated that exercise can be considered as an external indicator which can inhibit brain aging. Exercise can induce neuro-vascularization and BDNF (Brain-Derived-Neurotrophic Factor) production which delay the brain aging. Exercise can increase telomerase activity, telomere length and its stability. Moreover, circulating BDNF, fibronectin-3, Irisin and ketone bodies are other factors which may be affected by exercise and can affect various functions on central nervous system which can lead to brain plasticity and functional improvements.[6,7] BDNF is an important indicator for brain function and synaptic transformation which can be induce by exercise and mRNA expression. As a result, it can lead to neural and brain plasticity along with brain functional and structural adaptation in response to environmental stimuli.[8]

Why brain plasticity is important?

During past decades, the effect of exercise on brain plasticity has gained a lot of attention. Studies have suggested that lifestyle can improve brain plasticity, brain structure and its function which can decrease the risk of neural-cognitive impairments. It seems that aerobic exercise can affect frontal region of hippocampus by increasing gray matter.[9] Studies using fMRI (functional magnetic resonance imaging) on brain, has shown that brain plasticity will increase in the mentioned region and code-processing will be better along with improvement in brain function. This result, has made researcher to investigate the relation between exercise and brain plasticity. The results from the studies have indicated that there is a relation between cardio-vascular endurance and brain plasticity, which means that individuals with better aerobic endurance, have better brain plasticity and motor networking which can be achieved even by single bout of training. Researcher have then started to assess the effect of resistance training on brain function and brain plasticity which indicated the similar results.[10]

Molecular pathways for the effect of exercise on brain health

How can exercise improve brain plasticity?

Regular exercise can improve brain function, synaptic flexibility and BDNF especially in hippocampus. This result has also been achieved by single bouts of training. One suggested mechanism for the effect of exercise on brain plasticity, is due to increase in the level of Endocannabinoids and Andamide along with increase in BDNF level.[11–14] Exercise can affect cell growth and differentiation, which increase the demand for nutrients. In response to cell growth and need for nutrients, vascularization will occur which can provide nutrients which is not only for hippocampus, but also for motor cortex and frontal lobe origin that ultimately lead to learning and brain plasticity.[15,16] Furthermore, exercise can increase the number of synapses in hippocampus and BDNF gene expression.[17]

Exercise effect on cognitive function

Increase in physical activity status and recruiting regular exercise, may improve cardio-respiratory fitness and capacity, help cognitive function and improve brain plasticity. Studies have suggested that this may be more important in older ages. Regular exercise for 3-6 months can improve cognitive function. Exercise with moderate intensity and/or stretch training for 6 month, 3 sessions/week, 30-45 minutes/ session can bring similar effect on brain plasticity and cognitive function.[18,19] This can be as a result of brain ability to be flexible and modifiable. As aging occurs, the brain tends to become smaller which is considered as atrophy. After the age of 55, both frontal and hippocampus region, will become smaller by 1-2% each year which can lead to decrease in cognitive function. It has been indicated that regular exercise can be an effective and preventative strategy for prevention of gray matter in frontal and temporal regions which can be as a result of aerobic and cardio-vascular capacity improvement.[20,21] In conclusion, physical activity and regular exercise, can bring beneficial health outcomes, not only for obesity, metabolic disorder, cardiovascular disease and other health complications, but can also improve brain plasticity due to the connection of several systems including skeletal muscle (exercise increase the demand for nutrients), cellular mechanisms (cell signaling and cell cascade),cardiovascular system(angiogenesis, vascularization) and central nervous system (neurogenesis, neural plasticity and brain plasticity).

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Conflicts of interest

The author declares no conflicts of interest.

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