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Conceptual Paper

Critical Evaluation of Physical Exercise on Brain Structure and Function

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Physical activity or physical exercise act against the sedentary lifestyle-induced health matters such as cognitive decline or neurodegenerative diseases. Physical exercise and physical activity is important for people of all age groups that not only could enhance mental capacity and social interactions development of pre-school aged children, but also could maintain and ameliorate muscle strengthening and health condition such as high blood pressure of old adults. Physical exercise also, acts as gene modulator which develops brain function due to structural and functional changes such as neurogenesis, glycogenesis, brain volumes, white matter integrity, neurotrophies levels and or cognitive performance [1,2].

Physical exercise conveys protective effects against cognitive functions and structures that decline especially of cognitive functions that relay on experiences (e.g. memory) [3]. Physical exercises also cause biological effects such as hippocampal neuroplasticity, prevention of hippocampal volume atrophy, increase grey matter volume in frontal and hippocampal region, and reduce damage in grey matter. It has been shown that physical exercise-induced cardiovascular fitness and increased blood flow lead to positive changes in hippocampus volume and causes better memory scores and enhances cognitive function in both young and older adults. Moreover, physically active children act much better on perceptual and verbal test while comparing to sedentary children at the same age. Physical exercise directly affects synaptic structure and enhances synaptic plasticity in hippocampus and facilitates spatial learning. In response to physical exercise, long-term potentiation (LTP) cause long-lasting increase in signal transmission and considered as physiologic base for learning. LTP is usually accompanied by increase of dendrite length and complexity. Physical exercise has an influence on hippocampus neurogenesis proliferation and function of nerve system which in turn influence LTP and memory formation [4].

Physical exercise dominantly regulates neural function by the activity-dependent synapse-to-nucleus signaling. There are some signaling proteins that run this signaling pathway such as NF-KB (e nuclear factor kappa-light-chain-enhancer of activated B cells), AIDA-1(amyloidal precursor protein intracellular domain associated-1 protein) and Abi1 (Abelson-interacting protein- 1). Amelioration or deterioration of these signaling proteins affects the brain function. To be concise, increase in the level these proteins could enhance brain function and plasticity. It has been shown that growth factors regulation is one of those effective mechanisms which mediates exercise-induced brain changes and enhance synaptic plasticity. Exercise-induced neural circuit blood circulation develops cognitive function. Doing repeated neural activity due to exercise needs neurovascular unit which support neural activity needs. Exercise-induced adaptation strengthens the blood brain barrier (BBB) and reinforce of neurovascular integrity which is damaged under the effect of brain functional loss. Integrins as transmembrane receptors for several proteins, add stability to BBB and provide further reinforcement to neurovascular integrity.

Another mechanism that physical exercise could ameliorate brain function is the cerebral reserve which is known as brain's ability to face against damage (e.g. stroke, trauma) over time and refers to the amount of brain damage the brain can sustain before overt clinical symptoms. There are two types of reserves: brain reserve that is based on anatomical features (such as brain size, neu-

ral density, and synaptic connectivity) and cognitive reserve that is based on the efficient connectivity among neural circuits. Physical exercise is one those interventions that could encourage reserves.

Briefly, physical exercise promote neurogenesis, control inflammation, decrease apoptosis, promote neurovascular unit, and upregulate neurotrophies expression [e.g. BDNF (brain derived neurotrophic factor), NGF (nerve growth factor), GDNF(glial cell line derived neurotrophic factor)] that consequently considered as acceptable alternative treatment for stroke, promote injured axon-regeneration, and control neuropathic pain [5].

In the recent years, due to advancement in science and technology and also other daily activities (work pressure, sedentary mode of life, etc.), physical exercise/ activity is missing among people. Moreover, other adverse problems of the society, pollution, alcoholism, etc., affect human body health through brain health [6-9]. In this context, physical exercise will be important for both brain health and body health through various protective mechanisms. In this industrial age, policy makers, government officials, health educators should reveal the importance of physical exercise and activity to students, adults, etc. through proper media [10].

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