Exercise and Brain Health

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Introduction

Exercise is well-known to improve physical function, metal health, and decrease the rates of mortality and morbidity (1). Data from the American Heart Association 2018 Heart and Stroke Statistics indicate that 50.3% of adults in the US do not meet the aerobic component of the physical activity guidelines of moderate intensity aerobic activity for 30 minutes, five days per week, or vigorous intensity aerobic activity for 20 minutes, three to four days per week (2). There is an increasing amount of evidence supporting the relationship between regular exercise and cognitive brain health (1). These benefits of exercise stem from improved vitality and function of the central nervous system along with promoting resistance against neurological disorders. Not only has exercise been found to improve cognitive health, but evidence also suggests that exercise may improve mental health (12). This is especially important as the cognitive, functional, and mental decline, in aging populations, becomes more apparent. This article dives specifically into the effects that exercise has on the decline in mental health associated with the global pandemic that is COVID-19. Learning about the ways in which exercise can affect our bodies is the first step in being able to prescribe and recommend exercise. The purpose of this article is to summarize the benefits that exercise can have on our brain health along with the age-group specific recommendations.

Fundamentals of Brain Health: Adolescence

Throughout infancy and up until adolescence, the brain undergoes dramatic development of sensory, cognitive, and behavioral functions (4). The brain's malleability, in adolescence, is highly susceptible to various modifiable lifestyle factors, the most important being physical activity (5). Studies suggest that the adolescent brain, compared to older individuals, is the most adaptable to achieve benefits from physical activity because it is undergoing extensive growth and maturation (5) Many of the changes, within the brain, that researchers focus on, involve the brain's white matter. White matter tracts, which are a bundle of nerve fibers, facilitate transmission between gray matter region, which in turn facilitate fundamental and complex cognitive processes (6). Growing evidence suggests that engagement in habitual physical activity, during childhood and adolescence, can influence gray and white matter integrity, potentially having implications for cognitive development (4).

It has been well established that participating in lifelong physical activity can delay the onset of many chronic diseases (4). The importance of physical activity for brain health has been supported by numerous studies indicating daily physical activity may protect against cognitive decline in later life (4). As the aging population continues to grow, the risk of older individuals developing cognitive and age-related neurodegenerative disorders also increases Therefore, establishing a daily exercise regimen early in life is crucial.

With the adolescent brain rapidly developing, it is critical that all the knowledge we have gained is applied to recommendations for physical activity in this stage of life. Understanding all the cognitive benefits associated with physical activity during adolescence will provide a foundation that is more likely to motivate more active lifestyles, in the youth populations, as well as to promote healthy neurocognitive structure and function that can provide benefits as we continue to age.

Brain Adaptations to Exercise

Studies have found that physical exercise has direct effects on brain health by altering mechanisms of neuronal plasticity, or the brain's ability to adapt to change, that is involves with learning and memory (7). In humans, a majority of the research relating the effects of physical activity on the brain have been conducted in older populations, mainly due to a greater presentation of functional decline in the brain. The aging brain undergoes selective atrophy, which targets specific muscle fibers, mainly in the prefrontal cortices and temporal lobes. Much of the research focuses on the impact that aging has on the hippocampus, which is located in the temporal lobe (1). The hippocampus is an important structure in the brain for declarative memory function. Hippocampal atrophy is a risk factor for the development of Alzheimer's disease (7). Studies have found that engaging in daily bouts of physical activity, from adolescence into adulthood, elevates hippocampal and prefrontal cortex volume later in life, contributing to better short-term and long-term memory and brain health (7).

Current research has provided evidence discussing the positive relationship between exercise and improvement in brain health. Researchers have proposed a new model detailing how and why physical activity influences human brain function. This model is known as the adaptive capacity model (8). In regard to the adaptive capacity model, researchers have provided a wealth of data demonstrating that 150 minutes of moderate-intensity aerobic exercise each week can induce neuroplasticity, the ability of the brain to adapt, in humans (8). Exercise triggers

hippocampal neurogenesis primarily through the upregulation of neuro-trophins, growth factors, and brain-derived neurotrophic factor. In addition, angiogenesis, the development of new blood vessels, and enhanced cerebral perfusion from aerobic exercise may play an important role in structural brain benefits (8).

Defense against cognitive decline and aging

In old age, there is a growing incidence of cognitive deficits. In humans, the brain naturally undergoes age-related atrophy of the frontal, parietal, and temporal regions, leading to a decline in cognitive and executive functioning (9). Cognitive decline is due to the combination of both intrinsic and extrinsic factors. Intrinsic factors include the individual's biological features such as age, gender, race and genetic factors. Extrinsic factors are mainly attributed to the individual's lifestyle, which can include physical inactivity (9). One of the most prominent intrinsic factors associated with cognition is an individual's age. Age-related atrophy of the brain results in decreased gray matter volume, which has been associated with decrements in a variety of cognitive control processes (10). Neuroimaging data suggests that physical activity not only spares age-related loss of brain tissue, but also enhances the structural health of specific areas of the brain, especially those that play a role in cognition (10).

Sedentary populations undergo a reduction in capacity, and adaptability, often predisposing populations to chronic disease (8). Physically active lifestyles provide physiological adaptations that maintain, or even improve, the functional capacity of the brain. Lifestyles with low amounts of physical activity may lead to a reduction of adaptive ability in the brain, also referred to as neuroplasticity, which can result in a more rapid decline in the aging brain.

Physical activity is one of the most effective strategies to prevent cognitive decline (11). Studies have found that physical activity has been associated with neuronal protection against age-associated alterations and is a non-pharmacological strategy for treatment with neurodegenerative disorders, such as Alzheimer's (11). Improvement in brain cortex mitochondrial function has been found in individuals that participate in regular physical activity, of at least150 minutes of moderate intensity aerobic exercise per week. This is accompanied by an increased fusion of healthy mitochondria, within the brain, and a segregation of damaged mitochondria. The increase in healthy and fused mitochondria diminishes the development of symptoms associated with the Alzheimer's neurodegenerative process (11). Despite the many

promising results found in these studies, further research is needed to find the exact mechanisms behind the relationship between exercise and cognitive functioning.

Mental health and COVID-19

2020-2021 has shocked the world with one of the worst global pandemics. COVID-19 has completely changed the way our society functions. With global quarantine rules being put into place many found themselves stuck inside for days on end. Neuropsychological disorders, such as anxiety and depression, have become more and more prevalent since the onset of the pandemic (12). Recent studies have been conducted to find the relationship between physical exercise and the prevalence of stress, anxiety, and depression, in the general population, during the COVID-19 pandemic (12). Studies suggest that aerobic and resistance training, types of physical exercise, had beneficial effects on physiological and mental health in humans.

With the COVID-19 pandemic bringing so much unknown into people's everyday lives, it is not uncommon to experience some form of anxiety. Evidence suggests that a regular physical exercise routine can improve symptoms of anxiety (12). As the COVID-19 pandemic has led to a mental health decline in many individuals, researchers are looking into ways in which physical exercise may increase levels of dopamine being released in the body. Dopamine is a neurotransmitter found in our body that plays a role in how we feel pleasure. Dopamine is also found to regulate emotion and reward-related functions of the brain. It has been suggested that the benefits of physical activity are related to increase dopamine concentration (3). As individuals participate in more physical activity, the level of dopamine released will increase during exercise. As more dopamine is being released, individuals may have reduced levels of stress, anxiety, and depression, and improvements in mental health (3).

So much is still unknown about the COVID-19 pandemic. Much of the research included is still fairly new and requires more future research. Studies have suggested many possible positive connections between mental health and physical exercise, however the relationship between certain neuropsychological disorders, such as anxiety, and the COVID-19 pandemic must be further investigated in order to develop forms of prevention and treatment.

Conclusion

To receive the best benefits from exercise for brain health, a physical activity routine should start at an early age. Physical activity during childhood and adolescence can develop protection against cognitive decline in later life (4). If the physical activity recommendations are

applied throughout life, the neural plasticity, will have great improvements. Healthy, adults aged 18 is 65 years old, should participate in moderate intensity aerobic physical activity, for a minimum of 30 minutes, five days per week, or vigorous intensity aerobic activity for 20 minutes, three to four days per week. Along with aerobic activity, resistance training, such as weightlifting, should be included in a daily exercise routine to strengthen the muscles of the body (2). Studies have found that engaging in the recommended amount physical activity may present with an elevated hippocampal and prefrontal cortex volume, contributing to better cognition and brain health (7). Not only can physical activity provide improvements in our cognition, but it can also improve our mental health, positively benefitting those that experience certain mental disorders, such as anxiety and depression. As the prevalence of anxiety and depression has greatly increased during the past year, aerobic activity, such as running, and resistance training, such as weightlifting, have become a more encouraged option as a coping mechanism for the COVID-19 pandemic (12). With the abundance of evidence that supports the positive relationship between physical activity and brain health, it is crucial that knowledge gained is shared with individuals around the world. As exercise physiologist, it is our job to encourage populations to participate in daily aerobic activity and resistance training, while educating them with all the positive benefits.

Additional Elements

Apply It

• It is recommended that our society strives to participate in moderate intensity aerobic physical activity, for a minimum of 30 minutes, five days per week, or vigorous intensity aerobic activity for 20 minutes, three to four days per week.

• Health and fitness professionals should now be able to educate sedentary populations on the negative effects of continuing that type of lifestyle, such as brain and muscle atrophy, and provide them with the knowledge to become more active and healthier individual.

Bridging the Gap

Physical activity has proven to be beneficial towards improving the health of all populations. Developing an exercise routine during adolescence will allow an individual to be more suitable to gain all the advantages of exercise later in life. If the physical activity recommendations of moderate intensity aerobic physical activity, for a minimum of 30 minutes, five days per week, or vigorous intensity aerobic activity for 20 minutes, three to four days per

week, are met, populations may experience a decrease in mental decline, an increase in the brain's ability to adapt to the changes associated with aging, and an improvement in mental health.

Summary Statement

The natural process of aging, along with the mental health effects associated with the COVID-19 pandemic, are plaguing the world that we live in today. It has been acknowledged that a more active lifestyle can have many positive effects on the mental and cognitive health of every population.

Pulled Text

Physical activity is one of the most effective strategies to prevent cognitive decline (12). Studies have found that physical activity has been associated with neuronal protection against aging associated alterations and is recommended as a preventative non-pharmacological strategy in the management of patients with neurodegenerative disorders, such as Alzheimer's. Neuroimaging data suggests that physical activity not only spares age- related loss of brain tissue, but also enhances the structural health of specific areas of the brain, especially those that play a role in cognition (10). Not only can physical activity provide improvements in our cognition, but it can also improve our mental health, positively benefitting those that experience certain mental disorders, such as anxiety and depression.

Bio:

Quinn Truyol is currently pursuing her bachelor's degree, for exercise science, at the University of New Mexico, where she is also a member of LoboThon and the Pre-PT Club. Her interests include working out, dancing, and volunteering with kids.

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