E-ISSN:2319-3050

Review Article

Health and Wellness

International Journal of Research Padagogy and Technology in Education and Movement Sciences

2023 Volume 12 Number 02 APR-JUN

Publisher

www.theuniversityacademics.com

Physical Activity and Neurocognitive Health: A Narrative Review

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DOI: https://doi.org/10.55968/ijems.v12i02.268

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The literature survey shows improvement of cognitive and neurocognitive health through Physical Activity (PA) or exercise. However PA promotes the production of neurotrophins, leads to better brain plasticity.Your brain can decrease in size without use, and can be damaged from stress and depression. Exercise produces neurochemicals which reverse the damage and increase the size of your brain on the other handneurons in your brain connect like branches. With exercise, you can increase branch growth and improve brain function so;PA is an essential element for developing cognitive and neurocognitive health.The specific aim of this review paper is to magnify the effects of physical activity on neurocognitive health.Numerous related literatures were evaluated for this study from various online database and for screning of Prefered reporting items for this narrative study PRISMA 2020 guideline was applied . All appropriate literature that fulfills the primary objective of the study were scientifically presented in this review paper.This review compiles many studies established that regular habit of PA improve neurocognitive health.PA is very much effective for neurocognitive health. Regular involvement in PA improve many neurocognitive domain like: attention span, memory, executive function, social cognition, learning, perception, judgment ability etc.

Keywords: Physical Activity, Cognitive, Neurocognitive Health, Neurochemicals,Neurotrophins and Brain Plasticity

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How to Cite this Article

Nasima Khatun, Prosanta Paul, Sridip Chatterjee, Sudip Sundar Das, Physical Activity and Neurocognitive Health: A Narrative Review. IJEMS. 2023;12(02):94-101.

Available From

https://ijems.net/index.php/ijem/article/view/268

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Manuscript Received	Review Round 1	Review Round 2	Review Round 3	Accepted
2023-03-01	2023-03-22	2023-04-12	2023-04-19	2023-05-17

Conflict of Interest	Funding	Ethical Approval	Plagiarism X-checker	Note
NIL	NO	YES	18	

Introduction

According to WHO physical activity as any bodily movement produced by skeletal muscles that requires energy expenditure. PA encircles all activities, at any intensity, performed any time of day or night. Itcomprises both exercise and accessory activity integrated into daily task. There is a close relationship of PAon cognitive and Neurocognitive health.Cognition refers to the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses on the other handNeurocognitive functions are cognitive functions closely linked to the function of particular areas, neural pathways, or cortical networks in thebrain, ultimately served by the substrate of the brain's neurological matrix (i.e. at the cellular and molecular level). Few scientific evidences shown that PA improves cognitive and neurocognitive health but the evidences were not clearly explain the mechanism that, how regular PA effect on cognitive and neurocognitive domains, that is why the researcher have chosen this study.

Theories of cognitive health:

The cognitive theory definition asserts that the way people behave is a product of the information they gather externally and the way they interpret that information internally. There are many theories of cognitive health few important theories of cognitive health are as follows: Jean Piaget (1936) is famous for his theory of cognition that considers four specific stages of development.The sensorimotor stage (0–2 years) is when infants build an understanding of the world through their senses and movement (touching, feeling, listening, and watching).The pre-operational stage (2–7 years) is when language and abstract thinking arise. This is the stage of symbolic play. When a child is 7 years old, they enter Piaget's concrete-operational stage, which goes up to 11 years. This is when logical and concrete thought come into action.At the age of 11 onward, children learn logical and abstract rules and solve problems. Piaget described this as the formal operational stage.Lev Vygotsky described an alternative theory. He believed that children's cognitive development arises through their physical interaction with the world (Vygotsky, 1932). Vygotsky's theory is based on the premise that the support of adults and peers enables the development of higher psychological functions.

Another more modern theory, similar in some sense to Vygotsky's, is one by American psychologist Urie Bronfenbrenner (1974). He suggested that a child's environment, within an arrangement of structures, has a differing impact on the child (Bronfenbrenner, 1974).Bronfenbrenner's five structures are the micro-system, mesosystem, ecosystem, macrosystem, and chronosystem. These concern the surrounding environment, family, school, values, customs, and cultures. They are interrelated, with each system influencing others to impact the child's development (Bronfenbrenner, 1977).On the basis of transforming of learning there are three cognitive development theory : Dual coding theory, Cognitive load theory, Cognitive theory of multimedia learning.Dual coding theory deals with verbal and non verballearning.Cognitive load theory deals with intrinsic load (difficulty that is inherent in the content itself)

Extraneous load (information or activity that is not needed for learning),Germane load (cognitive processing that assists in the formation of learner schemas.).

Theories of neuricognitive health:

Neurocognitive theories emphasis the crestive process and person. There are four major theory of neurocognition: Theory of mind, Executive functioning theory, Central coherence theory & Learning and educational implications theory.TOM refers to the ability to understand the desires, intentions & beliefs of others , and is a skill that develosbetween three to five years childrens.Executive functioning theoy are widely use in ASD patients. Some survey says that 80% of those with ASD suffer from executive function disorder.Some persons are facing difficulties in managing time, completeing task. Some persons are unable to respond organised way. Executive function is the cognitive processes that help us regulate, control and manage our thoughts and actions.It includes planning , working memory, attention, problem solving verbal resoning, inhibition, cognitive flexibility & monitoring of action. The third major theory of autism is that weak central coherence proposed by Uta Frith in 1989.Central coherence was the term given to a human being's ability to derive overall meaning from a mass details. Apersonwith strong central coherence , looking at an endless expanse of trees,would see "the forest." Aperson

With weak central coherencewould see only a whole lot of individual trees.Forth theory of neurocognitive health deals with learning and educational process.Teachers' can facilitate a life time of successful learning by equipping students with a repertoire strategies and tools for learning. The teacher plays an important role in the educational process. Effective teaching depends upon the evolution of innovative strategies and also the methodology of teaching.Brain cells communicating with each other throug on electrochemical process.neurocognition includes perceiving recognising, conceiving, judging and reasoning processes.The teachers must develop the competencies like content competency, contextual competency, classroom management and evaluation competency which helps to develop neurocognitive health of children.

Methods

For collection of evidences for this narrative study the researcher used online searching engine: Pubmed, Medline, Scopus, web of sciencs, Science Hub,etc by using following keywords Physical Activity, Cognitive, Neurocognitive Health, Neurochemicals,Neurotrophins, brain plasticity and for Screnning of the evedences PRISMA, 2020 guideline was applied.In the present study the researcher included only english language paper which is the limitation of the study. Conference proceding of abstract were not included in this present study.

Fig.1.PRISMA 2020 flow diagram for searches of database registers

Enclosed as Annexure 01

The search strategy guided the flow of articles through the review process (Figure.1)first researcher identified 57 evidences from online sources. Due to ireleventevendence 31studies were excluded. Afterthat 5 studies were excluded for other language and coferenceprocedings, later 4 evidences were excluded because those studies were deals with specific disorder, 2 study were excluded for low standard and more 2 study were excluded because these are not able to access so, for this review paper researcher finally included 13 studies which fulfills the primary objective of the studies.

Domaions of Neurocognitve Health

Neurocognitive health depends on function of domains. These domains are hierarchical in nature, with the bottom referring to more basic sensory and perceptual processes and the top referring to elements of executive functioning and cognitive control. Within each domain there are few sub domains also which indicate component ability of main domain. All neurocognitive domains are linked with the brain in which processes were seen to be occurring.

Fig.2. Schematic diagram of Domains and sub domains of neurocognitive health.

Enclosed as Annexure 02

Exercise and Neurocognitive Health

Regular exercise effects on brain structure, brain function, cognitive and neurocognitive function. Scientific evidences shown that consistent aerobic exercise increase neuron growth, enhanced cognitive control of behavior, improved declarative, spatial, and working memory, improved stress copingabiliy, structural and functional improvements in brain structures and pathways associated with cognitive control and memory.PA increases the production of neurotrophic factors(e.g., BDNF, IGF-1, VEGF) which mediate improvements in cognitive functions and various forms of memory by promoting blood vessel formation in the brain, adult neurogenesis,and other forms of neuroplasticity. Consistent aerobic exercise increased gray matter volume in nearly all regions of the brain which improve executive functions (e.g., attention, working memory, cognitive flexibility, inhibitory control, problem solving, and decision making). Aerobic exercise induces short- and long-term effects on mood and emotional states by promoting positive affect, inhibiting negative affect. The effects of exercise on neurocognitive health have important implications for improving academic performance in children and college students, improving adult productivity, preserving cognitive function in old age, preventing or treating certain neurological disorders, and improving overall quality of life.

Discussion

The collective evidence from various sources may not be adequate but still it claims that regular doing PA improves neurophysiological growth. Research on PA and neurocognitive health

Is quite limited. Below all studies were explain with mechanism which conducted on PA and neurocognitive heath to find out the relationship between PA and neurocognition.

Paillard T et al.2015, suggestthat, Aerobic physical exercise (PE) activates the release of neurotrophic factors and promotes angiogenesis, thereby facilitating neurogenesis and synaptogenesis, which in turn improve memory and cognitive functions. ... Exercise limits the alteration in dopaminergic neurons in the substantia nigra and contributes to optimal functioning of the basal ganglia involved in motor commands and control by adaptive mechanisms involving dopamine and glutamate neurotransmission.

According to McKee AC et al. 2014, the benefits of regular exercise, physical fitness and sports participation on cardiovascular and brain health are undeniable. Exercise also enhances psychological health, reduces age-related loss of brain volume, improves cognition, reduces the risk of developing dementia, and impedes neurodegeneration.

Denham J et al. 2014, report shows that Aerobic physical exercise produces numerous health benefits in the brain. Regular engagement in physical exercise enhances cognitive functioning, increases brain neurotrophic proteins, such as brain-derived neurotrophic factor (BDNF), and prevents cognitive diseases.

Cox EP et al. 2016, A range of validated platforms assessed CF across three domains: executive function (12 studies), memory (four studies) and processing speed (seven studies). In studies of executive function, five found a significant ES in favour of higher PA, ranging from small to large. Although three of four studies in the memory domain reported a significant benefit of higher PA, there was only one significant ES, which favoured low PA. Only one study examining processing speed had a significant ES, favouring higher PA.

Basso JC et al.2017, suggest that, A large collection of research in humans has shown that a single bout of exercise alters behavior at the level of affective state and cognitive functioning in several key ways. In terms of affective state, acute exercise decreases negative affect, increases positive affect, and decreases the psychological and physiological response to acute stress. These effects have been reported to persist for upto 24 Hours after exercise cessation. In terms of cognitive functioning, acute exercise primarily enhances executive functions dependent on the prefrontal cortex including attention, working memory, problem-solving, cognitive flexibility, verbal fluency, decision-making, and inhibitory control.

Szuhany KL et al.2014, study indicate Consistent evidence indicates that exercise improves cognition and mood, with preliminary evidence suggesting that brain-derived neurotrophic factor (BDNF) may mediate these effects. The aim of the current meta-analysis was to provide an estimate of the strength of the association between exercise and increased BDNF levels in humans across multiple exercise paradigms.

Lees Cetal.2013, This omission is relevant, given the evidence that aerobic-based physical activity generates structural changes in the brain, such as neurogenesis, angiogenesis, increased hippocampal volume, and connectivity . In children, a positive relationship between aerobic fitness, hippocampal volume, and memory has been found Mental health outcomes included reduced depression and increased self-esteem, although no change was found in anxiety levels .This systematic review of the literature found that [aerobic physical activity (APA)] is positively associated with cognition, academic achievement, behavior, and psychosocial functioning outcomes. Importantly, Shephard also showed that curriculum time reassigned to APA still results in a measurable, albeit small, improvement in academic performance.

Tarumi T et al.2014, study shows that, Exercise-related improvements in brain function and structure may be conferred by the concurrent adaptations in vascular function and structure. Aerobic exercise increases the peripheral levels of growth factors (e.g., BDNF, IFG-1, and VEGF) which cross the blood-brain barrier (BBB) and stimulate neurogenesis and angiogenesis.

Batouli SH et al.2017, The results of this study showed that a large network of brain areas, equal to 82% of the total grey matter volume, were associated with PA. This finding has important implications in utilizing PA as a mediator factor for educational purposes in children, rehabilitation applications in patients, improving the cognitive abilities of the human brain such as in learning or memory, and preventing age-related

Brain deteriorations. ... There is a significant association between the volume of the brain areas and their corresponding functions. Examples include the association of total and regional brain volumes (BV) with executivefunction and speed of processing,intelligence, working, verbal and spatial memory, and skill acquisition performanc e.

Bhattacharya P et al.2022, suggest that, regular practice of karate, Taichi, taekwondo and combined martial arts show increment in neurochemicals like BDNF, brain potentials and brain plasticity. Karate training intervention being beneficial in enhancing stress tolerance and motor stability , the same when performed for prolongrd period improve resiliene, attention and motor reaction time.

Janssen M et al.2014, There is weak evidence for the effect of acute bouts of physical activity on attention.Fortunately, the literature-base on the acute effect of PA on the underlying cognitive processes of academic performance is growing. Hillman et al. (2011) found in their review a positive effect of acute PA on brain health and cognition in children, but concluded it was complicated to compare the different studies due to the different outcome measures (e.g. memory, response time and accuracy, attention, and comprehension). Therefore, this review focuses on the sole outcome measure 'attention' as a mediator for cognition and achievement.

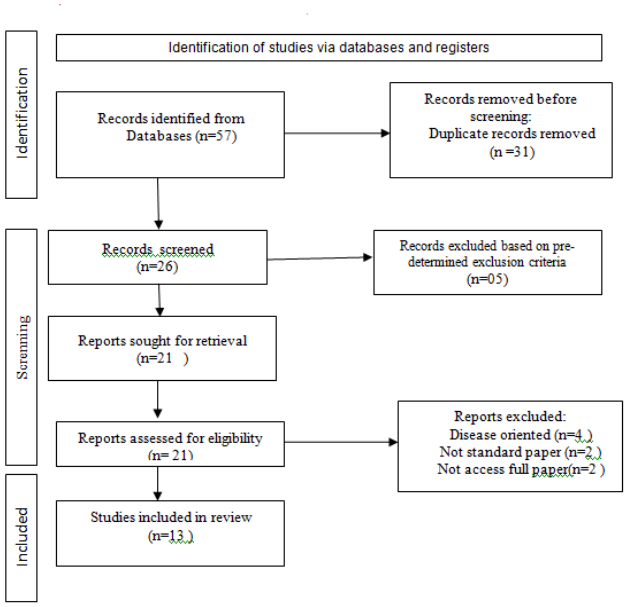
Conclusion

There are several analysis conducted on PA and neurocognitive health which indicate neumerous effect of PA on neurocognitive function: incresse neuron growth, enhance cognitive control of behaviour, improve structure and function of brain, increase grey matter of brain which improve executive function of an individual,increament of neurochemical like BDNF brain potentials and brain plasticity, improve academic performane ,stress coping ability and also treating certain neurological disorder. So regular PA develop each and every domains working ablity of neurocognitive function which finally improve ovarall neurocognitive health .

Annexure

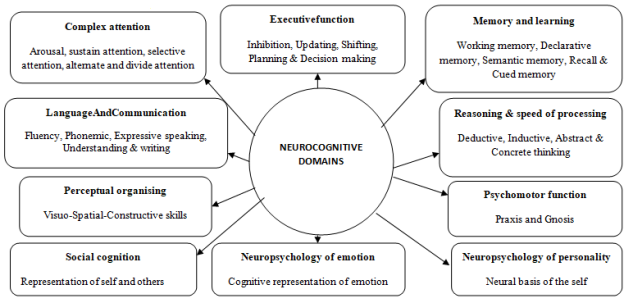
Annexure 01

Fig.1.PRISMA 2020 flow diagram for searches of database registers



Annexure 02

Fig.2. Schematic diagram of Domains and sub domains of neurocognitive health.



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