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Research Paper

Leg exercise: critical to brain and nervous system

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ABSTRACT

Engaging in leg exercises can have a profound impact on the health of the brain and the nervous system. Various researches have delved on the impacts of exercises on the functioning of the brain. There are limited researches that specifically dealt with the impacts of leg exercises on the health of the brain and nervous system. The present research paper sought to investigate the impacts of leg exercises on the health of the brain and the nervous system. Qualitative research approach was used to carry out the study. Qualitative content analysis was applied to analyze secondary data. The analysis of the collected data produced key themes such as prevention of certain illnesses, enhancing learning and memory, attention, growth and development. It was ascertained that exercises play a significant role in improving the health of the brain and the nervous system. The leg exercises send signals to the brain that stimulates the production of more healthy neurons. Additionally, the legs have one of the highest number of muscles in the body. Aerobic exercises are very effective in enhancing the functioning of the brain.

Keywords: *Leg Exercise, Nervous System*

Regular physical exercise has been part of our life for centuries. It can be traced back to the Indian community with the onset of yoga (Barough, 2016). Yoga originated in India about 5,000 years ago and it involves many routines that are distinct. About 1,500 years ago, Chinese practiced martial art as a form of physical exercises (Barough, 2016). Martial art incorporated *tai chi*, *qi gong* and *kung fu* (Barough, 2016). In ancient Greece, a physical exercise program was formulated approximately 2,500 years ago (Barough, 2016). This program led to the initiation of Olympic Games. In 776 BCE (Barough, 2016) the first Olympic Games were held and they comprised of activities involving the lower body such as skiing, ice skating, cycling and triathlon. In the last century, researchers have been engaged in establishing the benefits of regular body exercise. These studies have shed light on the impact of physical exercise especially to the physical and mental wellbeing including leg muscles exercises which encompass activities such as walking jogging, running and cycling (Hamer & Chida, 2009).

Leg exercise is a type of a lower body exercise. These lower body exercises are meant to work on the muscles that are below the waist line. They involve stretching and weight-bearing or non-weight bearing resistance (Bishop, 2011). Stretching is important and it is

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incorporated in between various exercise regimens. Examples of stretches that involve the lower body are hamstring stretch, lunge stretch, calf stretch, quad stretch and the spine twist (Bishop, 2011).

Leg exercises can be machine or non-machine assisted. Those that are done using a machine include leg extensions focusing on the quads in the upper legs; leg curl that involves the hamstring muscles; hip abduction that engages the inner thighs; and the calf raise (Bishop, 2011). Leg exercises that are non-machine include squats and lunges for the front upper leg muscles, hamstring, hip flexors, calf muscles and glutes (Bishop, 2011).

Leg exercises are crucial for toning of muscle mass and in the general wellbeing of a human being (Barough, 2016). In fitness centers, lower body exercises are incorporated in most fitness routines. These fitness routines are often featured in various fitness magazines globally. Lower body exercises including leg exercises are done for many reasons. These reasons vary from strengthening muscles to a body building routine mainly for competitions (Bishop, 2011). These exercises are also important for sportsmen especially involved in playing soccer, cross country running, cycling, dancing, fencing among many other sports.

Statement of the Problem

Physical exercises take many different forms. Each has its own distinct use and benefit. Research show that physical exercise impacts positively on the physical health of human beings. In addition, recent findings indicate that physical exercise also impact on brain health and the nervous system (Colcombe & Kramer 2003). Cognitive abilities tend to become more effective when an individual is active and primarily engaging in even light but regular physical exercises.

It is projected that by the year 2060, the population of the senior citizens in the USA will have risen to 92 million from 43 million in the year 2013 (Kirk-sanchez & McGough, 2013). This is a 100% increase of people aged 65 years and older. Aging is normally accompanied by a significant decline in cognitive abilities. It also comes with several neurodegenerative diseases such as dementia and Alzheimer (Ohman, Savikko, Strandberg & Pitkala, 2014). Physical exercises play a positive role in alleviating the effects of aging on the brain by slowing down age related decline in the functioning of the central nervous system (Cotman & Berchtold, 2002). With an increased aging population, alleviating the effects of aging particularly on the cognitive function has become critical. Aging comes with significant changes not only in the functioning of the central nervous system but also in the brain structure. Colcombe & Kramer (2003) explains that hippocampus is increased in size when older adults engage in physical activity. In addition, physical exercise impacts on brain plasticity. A study conducted by Erickson, Voss, Prakash, Basak, Szabo, Chaddock, Kim, Heo, Alves, White, Wojcicki, Mailey, Vieira, Martin, Pence, Woods, McAuley and Kramer (2011) revealed that physical exercise impacted on the volume of grey matter in the frontal and hippocampal areas in the brain. These in turn has effect on various cognitive functions such as attention spans and memory abilities.

There is a correlation between physical exercises with attention, memory and learning. These cognitive functions tend to be more effective and efficient when an individual is proactively engaged in physical exercise. Erickson et al. (2011) explains that in young adults and older individuals, participating in physical exercise serves to enhance storage and retrieval of information from the brain, it also increases one's attention span and boosts

executive functions of the brains. This executive function include problem solving skills, decision making skills, working memory, planning and execution of decisions.
Leg exercise is among the most common physical exercise done by individuals who proactively engage in fitness activities. Notable leg exercise includes walking, running, crouching, lifting and cycling. These are exercises that specifically designed to strengthen the muscles on the legs. With leg exercise come larger muscles that are a greatly enhances athletic performance. While a lot of research focusses on the general impact of physical activities/exercise, minimal research has focused on the impact of leg exercise to the brain and nervous system. The aim of this paper is to add to the knowledge there exist on the importance of leg exercise particularly to the wellbeing of the brain and nervous system.

Research Questions

1. How does leg exercise affect the nervous system?
2. How does engaging in leg exercise affect the size of the brain?
3. How does the health of the brain improve by engaging in leg exercise?

Study Objectives

The main objective of this research is to investigate and determine the influence of leg exercise on the brain and nervous system. This paper will determine how leg exercises affect the functioning of the nervous system, the health of the brain and also how it impacts on the brain size.

Purpose of the Study

The purpose of this study is to find out the impact of leg exercises on the brain and nervous system. The information obtained will add to knowledge there is on the impact of physical exercises on the psychological wellbeing of human being and primarily the leg exercises.

Justification of the Study

There are numerous studies that have been carried out focusing on the impact of physical exercise on the general wellbeing of a human being. However, there is need to understand how it affects the psychological welfare of a person. The main reason of carrying out this research is to understand the impact of leg exercise on the brain and the nervous system. This research will add to the knowledge there is on importance of physical exercise and primarily the leg exercises.

REVIEW OF LITERATURE

The connection between the wellbeing of the central nervous system and physical activity is a subject that has been studied widely. Several researches have been conducted that have indicated that there exist a correlation between physical exercise and the health of the brain (Lezak, 2004). Leg exercises are among the physical exercises that researchers have been investigating to establish its effects to the brain and the nervous system. Studies show new neurons are generated when an individual delves in leg muscle exercises (Adami, *et.al.* 2018).

Astronauts and people who have been in prolonged bed rest mainly due to health conditions tend to experience several physical challenges. These challenges vary from muscle impairment to issues to do with the performance of their central nervous system. Studies indicate that there exist a strong correlation between movement and brain function. It is reported that when damage occurs in a particular area of the brain that is associated with movement, the brains attempts to repair itself through a process called neuroplasticity (Baek,

2016). It is during this process that the brain neurons will try to remap their connections by prompting another section of the brain. In recent studies, researchers are digging dipper to establish the impact of voluntary physical exercise on the nervous system.

When adapted as a lifestyle, physical exercise may significantly reduce risks associated with cognitive disorders such as neurodegeneration (Baek, 2016). When people are active and are fond of engaging in physical exercises, their brains tend to be protected from cognitive disorders that are associated with aging. Studies conducted by Deng, Aimone, & Gage (2010) nullified a long-held belief that the human brain had no capacity for producing new neurons. More and more researchers have been engaged in studies whose findings suggest that physical exercise greatly enhance cognitive process in aging adults. Research suggests that physical exercise not only impact on human behavior but also greatly enhance critical cognitive processes such as learning, attention span, memory among other (Smith, Blumenthal, Hoffman, Cooper, Strauman, Welsh-Bohmer, Browndyke, & Sherwood 2010). A research conducted by Hamer and Chida (2009) established that when middle aged individuals engage in regular physical exercises their chances of suffering from dementia later in life is significantly minimized. This is proof that complications related to cognitions brought about mainly by aging can be reduced when one is proactively engaged in physical exercises.

Various longitudinal studies carried out by different researchers have established that the physical exercises, primarily those associated with leg exercise, have effect on the size of the brain. For example, a study by Erickson, Raji, Lopez, Becker, Rosano, Newman, Gach, Thompson, Ho & Kuller (2010) sought to establish whether participants who are involved in walking as a physical exercise would have a greater volume of the gray matter in the brain after a period of 9 years follow-up. The study incorporated 299 study participants whose average age was 78 years (Erickson et al. 2010). The researchers measured the association between the volume of the gray matter, physical exercise (walking) and cognitive impairment. Brain scans were done after 9 years on the research participants following a physical exercise assessment where white matter hyper-intensities, ventricular grade and other health measurements were taken (Erickson et al. 2010). 4 years later cognitive impairment among the participants was also measured (Erickson et al. 2010). The results indicated that walking was associated with greater gray matter in the brain and reduced risk of cognitive impairment (Erickson et al. 2010). This study and results from other studies (Rovio, Spulber, Nieminen, Niskanen, Winblad, Tuomilehto, Nissinen, Soininen, & Kivipelto, 2010) indicate that engaging in physical exercise is positively correlated with a greater volume of the grey matter into late adulthood.

Erickson et al. (2011) carried out a longitudinal study which was aimed at testing the hypothesis which stated that engaging in physical exercise increases the size of the hippocampus. The study involved 120 participants. These participants comprised of inactive adults without dementia. The participants were randomly assigned into two groups. The first group was a moderate intensity brisk walking group that composed of 60 participants and the other was a non-aerobic stretching control group of 60 participants (Erickson et al. 2011). Each of the two groups was given site-based exercises 3 times every week that lasted for 30-45 minutes (Erickson et al. 2011). Magnetic Resonance Images of the participants were captured before the commencement of the program, after 6 months and after the completion of the program. Results obtained from this study indicated that the participants who were involved in brisk walking showed a significant increase in the size of the hippocampus whereas the control group showed a decline in size (Erickson et al. 2011).

Moreover, the participants with increased size of the hippocampus had better fitness levels, improved spatial memory and increased levels of brain derived neutrophic factor (Erickson et al. 2011).

A study was carried out to determine the association between physical fitness and brain health. In this study the participants undertook a walking exercise. Opel, Martin, Meinert, Redlich, Enneking, Richter, Goltermann, Johnen, Dannlowski & Repple (2019) carried out an analysis of fitness and brain health among young adults totaling to 1,200 of an average age of 30 years. This sample was drawn from a group of volunteers from Human Connectome Project a survey project of individual interested in contributing to scientific research (Opel et al. 2019). The researchers were provided with MRI brain scans of the volunteers who also underwent additional testing. The volunteers were subjected to two tests. The first test was a walking test. The volunteers participated in a two minute walking test whereby they were encouraged to walk as fast as possible for a period of two minutes and the distance covered was captured (Opel et al. 2019). The second test was a cognitive test. These volunteers were subjected to a number of cognitive tests that measures memory, sharpness, judgment and reasoning (Opel et al. 2019). The results revealed that participants who walked faster and covered a larger distance performed better on the cognitive tests compared to the participants who were slower (Opel et al. 2019). In addition, the MRI scans revealed that participants who walked faster and further had healthier nerve fibers across the white matter in the brain (Opel et al. 2019). The result of this study suggests that leg exercise (walking exercise) generally improves cognitive performance of individuals.

A study by Baek (2016) sought to establish how exercise impacts on the central nervous system. He primarily focused on cognition, neurogenesis, neural plasticity and neurotrophic factors (Baek, 2016). The study reviewed several researches done on the topic. In the study it was established that neurotrophic factors play a key role in the regulations of the impact of physical exercises on brain plasticity (Baek, 2016). These are essential factors for human growth and development. The research also clearly brought out the fact that hippocampal neurogenesis is greatly affected by exercise (Baek, 2016). Exercise greatly impacts on neuronal development. When muscles are active especially during exercises, cognitive process such as learning, memory and neural plasticity are greatly enhanced. This research provides proof that exercise in positively correlated to several processes in the central nervous system. Cognitive functions such as neurogenis, synaptic plasticity and neurotrophic factors tend to be enhanced by exercise (Baek, 2016). The research gives evidence of the role of exercise in disorders especially related to neurodenegeration mainly in the aged brain (Baek, 2016). It was suggested that physical exercise should be a frontier considered while treating neurodegenerative diseases. It may give a noninvasive therapeutic option for the treatment of such disorders.

A research conducted by Adami et al., (2018) sought to determine the impact of extended disuse of muscles on neural stem cells. This research involved rats aged 4 months. The rats' hind legs were restrained using thin string that was tied to the tail though allowing the rat free movement using its forelimbs (Adami et al., 2018). This experiment was conducted for a period of 28 days. The rats' normal behavior was not restricted. They were able to eat and groom as they do in normal circumstances. After the 28 days the rats brains were dissected in conformity with the laws guiding protection of animals and the researchers examined the sub-ventricular zone of the brain (Adami et al., 2018). This is the brain area responsible for the production of new neurons by the neural stem cells (Adami et al., 2018). The results obtained were compared to a control group that had been let free to roam. The results

obtained indicated that the restriction decreased the neural stem cells by 70% as compared to the control group (Adami et al., 2018). It was also noted that the maturity of oligodendrocytes and neurons was severely affected when the physical exercise was minimized (Adami et al., 2018).

This research goes a long way in explaining the importance of leg exercise in brain health. It demonstrated that when suing the legs particularly when engaged in weight-bearing exercise, signals are sent to the central nervous system that positively impact on the production of new nerve cells (Adami et al., 2018). This production of new nerve cell is essential in the proper functioning of the central nervous system as it is responsible for elements that allow humans to handle stressful conditions and manage life dynamics. When one is not engaged in physical exercise the production of new nerve cells in inhibited thus affecting how we cope with different demanding situations in our life. Further analysis established that the level of oxygen in our bodies is negatively impacted by the lack of exercise (Adami et al., 2018). This results to anaerobic environment in the body which affects metabolic process. This research provides useful insight in important health issues particularly some life-threatening diseases such as multiple sclerosis. It highlights the critical role of movement in the general wellbeing of humans.

While examining the effects of physical activity on attention-deficiency disorder, Gapin & Etnier (2010) found out that exercise impacts both behavioral and cognition of children suffering from attention–deficit/hyperactivity disorder. This research proposed that physical exercise could be implemented as a safe and effective therapeutic procedure in the management of this disorder. This research highlights on how leg exercise can be incorporated as a therapy for the management of attention–deficit/hyperactivity disorder. Gapin & Etnier (2010) explains that cardio exercises which include treadmill exercises, dancing and running are quite effective in enhancing cognitive and physical functions among children suffering from attention–deficit/hyperactivity disorder.

Findings from several researches conducted on animals also provide more insight on the positive impact of exercise on functioning of the central nervous system. These findings have alluded that exercise greatly enhances hippocampal neurogenesis in adults. A study conducted by Heo, Shin, Kim, Kim, Baek, & Baek, (2014) found out the physical exercise not only positively impact on hippocampal neurogenesis but also improves performance on the Morris water maze. This is an indication that exercise enhances neuronal plasticity and the process of neuronal cell production. Exercise increase blood flow in the central nervous system and enhance angiogenesis (Yau, Gil-Mohapel, Christie & So, 2014).

Studies have been carried out to determine the role of exercise in improvement of cognitive functions and the effects exercise has on various areas of the brain. These studies have played a critical role in advancing knowledge on cognitive functioning, various cognitive processes and also provided insights in the prevention and management of several disorders related to the central nervous system. However, considerably few researchers have delved on the impact of different types of exercises and the impact these exercises have on the brain. These types of exercises vary from aerobic, balance and flexibility. The aim of this research paper is to provide insight on the effects of leg exercise, being an aerobic type of exercise, on brain and nervous system.

Summary of the Literature Review

Previous researches carried out have shown that there is a correlation between the general exercises and the health of the brain and the nervous system. Leg muscle exercises lead in the formation of neurons (Adami et.al.2018). Additionally, when a part of the brain is damaged, doing exercises activates the brain to start automatic repairs in a process referred to as neuroplasticity. Additionally, it helps to minimize cognitive disorders such as neuro generation (Baek, 2016). Exercises result in the improved cognitive capabilities in processes such as learning, attention span, improvement of memory, among others (Smith et.al. 2010). The review of the literature has also shown that exercising can be used to reduce the possibility that a person will suffer from dementia if they exercise regularly at their middle age (Hamer and Chida, 2009). The presence of aerobic exercises such as those involving the legs create an opportunity for well oxygenated blood to flow to the brains, cerebral oxygenation. Therefore, there is a low possibility that the gray matter will be damaged due to lack of oxygen. It lessens the occurrence of hypoxia. Walking has been proved to result in the increase of hippocampus (Erikson et.al, 2010). The hippocampus plays a great role in the learning and memory. The leg is one of the body parts with many muscles in human beings (Muscolino, 2016).

However, there is a limitation in terms of content and context in regards to the direct contribution of the leg exercises on the health of the brain and the nervous system. The present research will seek to fill the identified gap through narrowing down to the impacts that leg exercises have on the brain and the nervous system.

RESEARCH METHODOLOGY

The purpose of the present study was to assess the impacts of the leg exercises on the health of the brain and the nervous system. In this research, qualitative research methodology is the preferred methodology. This research methodology was preferred mainly because of its inherent creativity. Through this methodology, the researcher is able to understand diverse aspects of human life experiences as nearly as possible as the research participants feet it or live it. There are several advantages attached to a qualitative research method. Key among them is being able to determine possible relationships and dynamic processes. The researcher is considered an integral part of any research. When using qualitative research method, the researcher is able to better gain insight of the issue under review and even be able to pick out issues that are often missed such as complexities and subtleties. An additional strength of the qualitative research method is that it allows for a dynamic and negotiated reality.

To understand the impact of leg exercise to the brain and nervous system, the researcher will utilize secondary data and secondary data analysis technique. Secondary data is information from researches that have already been carried out and published. Existing publications can either be private or public. To be able to maximize data collection, the researcher will focus beyond the variables expressed in the research questions. Using several available electronic databases, the research will rigorously tackle a variety of research topics related to the various variables raised in the research questions.

Online library databases that the researcher intends to use to collect secondary data include libraries such as EBSCohost research platform, Embase, Medline, Web of Science, google scholar and PubMed. Once logged into the various electronic databases, terms such as leg exercises, exercises, physical exercise, brain health, central nervous system and cognitive, aerobic exercises, will be used to draw out publications that relate to the research topic, that

is, leg exercise critical to brain and nervous system. Some search terms will be used alone while others will be used in combination with others. There were a total of 74 journal articles and books that were identified after making the primary search; both from the targeted online libraries and other sources. These journal and books were further screened through reviewing their respective titles and abstracts to ascertain whether they were relevant to the objectives of the present paper. Out of these, 31 papers were identified as duplicates. The remaining 43 journal articles and books would consequently be used for the main research work. However, they were still subjected to further scrutiny before final consideration. Resources that explicitly explained about the impacts of the general exercises towards the brain health or the nervous system were fully considered while others were used to get a general glimpse of the effects of doing physical exercises. The schematic representation below shows the criteria that was used to come up with the resources for the present study.

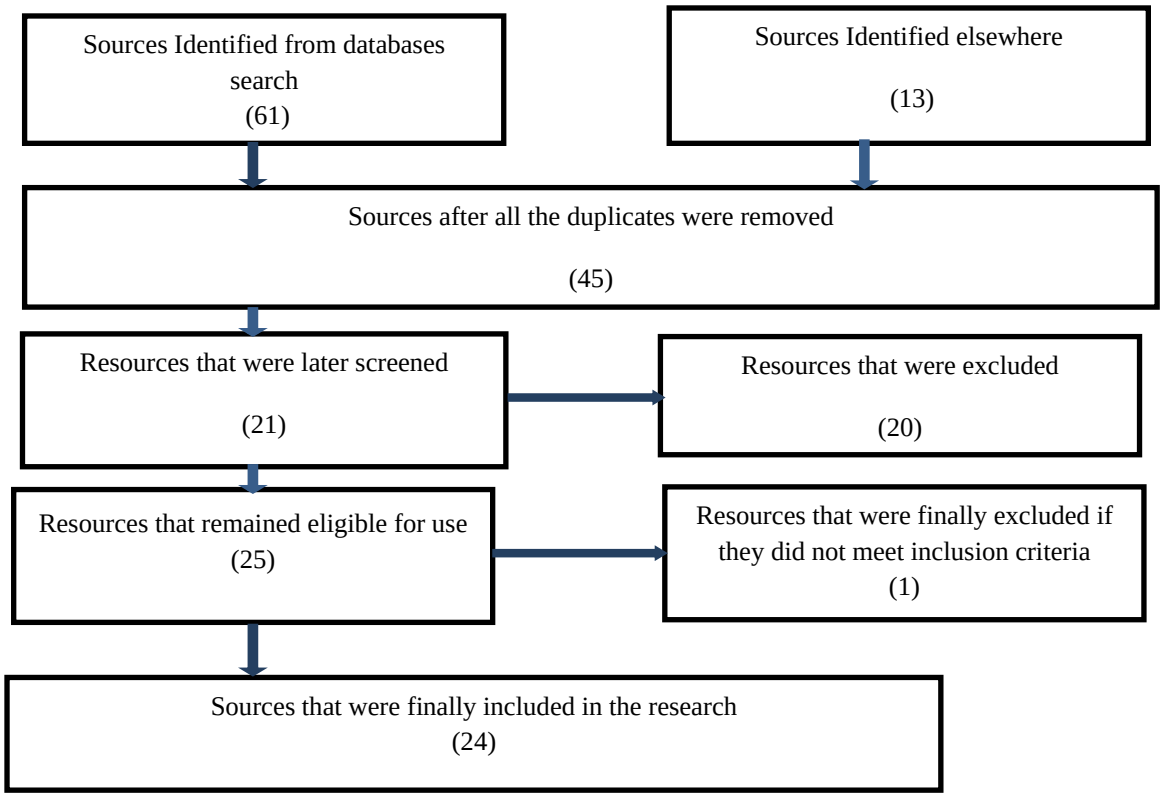

Figure 1: Representation of the Criteria used to come up with Research Resources

Exclusion and Inclusion Criteria

The research included journals and books that were published in the English language. Those that were published in other languages were excluded. The studies were expected to have discussed about exercises or general exercises and the impacts on either brain health or the nervous system. Aerobic related sources were also included. The main aim of the present research was to assess the impacts of the leg exercise on the health of the brain or the nervous system. The research sources that related to the other parts such as the hypothalamus, basal ganglia, and the other researches involving animals such as the mice were excluded from the present targeted resources. The sources that related to the effects of exercises on the peripheral organs apart from the brain and the nervous system were all exempted. There were other categories of sources such as those that related to the topics

such as the post-traumatic brain injury, injury in the spinal cord, various bodily dysfunctions, the concept of autism spectrum disorder, ADHD, were also excluded from the target sources. The included sources must have discussed about the exercises or aerobic exercises related in one way on the health of either the brain or the nervous system. The search was also limited mostly to the sources dating between 2009 to 2020. Databases search was conducted within four days and one day was used to make inclusion and exclusion.

Qualitative content analysis technique will be employed to analyze the available data from the research. Both the manifest and latent qualitative content analysis were employed. Qualitative content analysis has been chosen because it can be used to assess various past researches and develop an evidence-based practice on the current area of inquiry. While using this method, a researcher is required to interrogate his/her experience in the issues being studied so as to minimize the possibility of biases or subjectivity. Content analysis uses the data provided or drawn from the various sources and seeks to elicit meaning so as to draw realistic conclusions. The various stages involved in the data analysis include: decontextualization, recontextualization, categorization and lastly, compilation. The analysis process seeks to reduce the volume of data collected, identifies and groups categories together and consequently seeks to understand it. A meta-analysis of the chosen literature review will be carried out to draw inferences and conclusions.

DATA ANALYSIS

The present section presents the analysis of the collected secondary data. The data was analyzed using the qualitative content analysis technique; both the manifest and latent content analysis was employed.

The use of legs to exercise one's body, especially through the use of weight-bearing exercises, is said to send signals to the brain for production of new neural cells. Leg muscle exercises contribute to the generation of more neurons (Adami et.al. 2018). Therefore, the leg exercises are critical to the development of the brain and the nervous system in general. Being physically active has been noted to be one of the key methods of minimizing the chances of developing conditions such as diabetes, stroke and heart diseases (Godman, 2018).

In case any part of the brain is damaged, exercising activates the process of automatic healing and repair referred to as neuroplasticity (Baek, 2016). In addition, exercising assists to minimize various cognitive disorders such as the neurogeneration (Baek, 2016). Engaging in exercises also helps to improve cognitive processes, directly connected to the brain, such as learning, attention span, improvement of the memory, among others. On another point of view, exercises tend to reduce dementia at old age when middle aged individuals engage in regular exercises (Hamer and Chida, 2009). Walking increases the gray matter in the brain, which in turn assists in reduced cognitive impairment.

Walking has been identified as one of the techniques that increases the hippocampus (Erikson et.al. 2011; Godman, 2018). The hippocampus plays a great role in learning and memory. Exercises assist the memory and the thinking capability both in a direct and indirect ways. The *table 1* shown below shows the summary of the key studies that were used in the research.

Author	Summarized concept from the source	Contribution to the Present Research (Key topic)
Erikson *et. al.* (2011)	Walking increases the hippocampus	The study elicited the topic of learning and memory as a result of exercise
Godman (2018)	Walking increases the hippocampus Physical activity minimizes the chances of contracting illnesses such as diabetes, stroke and other heart diseases.	The study prompted the topic on learning, memory and Illnesses.
Hamer and Chida (2009)	Regular exercising at the middle-age period assists individuals to minimize chances of developing dementia at old age.	The study assisted to reveal the concept of minimizing chances of illnesses
Baek (2016)	Exercising activates neuroplasticity; technique of automatic brain repair. Exercising assists to minimize disorders such as neurogeneration	Topic of illness, growth & development.
Adami *et.al.* (2018)	Leg exercise contributes to the generation of more neural cells.	Topic of growth and development is stimulated.
Erikson *et.al* 2010	Increased levels of gray matter, which in turn helps to minimize the risk of cognitive impairment.	Topic of growth and development is derived
Smith *et.al* (2010)	Physical exercises assist in the development of human behavior and critical cognitive processes such as memory, learning and attention span.	Memory, learning, and attention are derived from the study.
Opel *et.al.* (2019)	Individuals who walk faster were found to perform better in a cognitive test.	Topic of learning
Gapin and Etnier (2010)	Physical exercise improves both the behavior and the cognition of children who suffer from the attention deficit hyperactive disorder.	Topic on attention and development
Yau et. al. (2014)	Exercise increases blood flow to the central nervous system.	Illnesses, growth and development
Muscolino (2016)	Legs form one of the body parts with many muscles compared to many body parts.	The muscles are connected to the central nervous system; directly linked to the brain.

Table 1: Summary of some of the reviewed Sources

The analysis of the results resulted in the data being grouped into five major themes; Memory and learning, Illnesses, growth and development; attention. The key analysis based on the identified group will be discussed.

Memory and Learning

Cognitive processes such as memory and learning are improved through the regular exercising (Smith, et.al. 2010). Research done by Hamer and Chida (2009) shows that the indulging in exercises helps increase the cognitive capacity in a human being. Walking increases the hippocampus, which plays a major role in both learning and memory (Godman, 2018; Erikson et.al. 2011).

Growth and development

Leg muscle exercises results on the growth and development of the neurons (Adami et.al 2018). They form the basic structures of the human brains and are used to transmit signals. Their increase would help support the functions of the brains. In addition, the exercises lead to the neuroplasticity process, which activates the repair of the brain when it is damaged (Baek, 2016). A damaged brain may not be effective in its operation. Automatic repair is important to assist the various organs or parts of the body to function properly. Being one of the central organs in the human body, brain needs regular repairs in case damaged to ensure the human behaviors and activities are well coordinated.

Attention

Engaging in leg exercises improves the ability of individuals to be attentive. Leg activity is very imperative to the individuals suffering from attention deficit hyperactivity disorder. Children especially are able to focus more on one activity after engaging in leg or aerobic exercises. Humans who engage in regular sporting activities report to perform better than those who engage in passive activities. Exercising increases the attention span of individuals (Smith, et.al. 2010).

Illnesses

Leg exercises assists to minimize the possibility of contracting certain brain related illnesses such as neurogeneration (Baek, 2016). This kind of a disorder affects the human cognitive functioning. Minimizing the ability of the illness to attack humans increases the wellbeing of the human brain. From another point of view, the development of dementia is a major problem among the aged. Leg exercises during the middle-age would assist to slow down the rate of contracting such illness. Hamer and Chida (2009) research shows that physical exercises, leg exercises included, assist to minimize dementia condition at old age if individuals regularly exercise while at their middle-ages. Erikson *et. al.* (2010) study showed that regular exercising, including aerobic exercises, would support increase in gray matter, which in turn reduces the risk of cognitive impairment in the brain. The aerobic exercises support cerebral oxygenation, which gives well oxygenated blood to the brains and minimizes the chances that the brain will get low level of oxygen, hypoxia.

DISCUSSIONS

The exercising of one's leg leads to boosting the body's metabolism. The leg has the largest muscles of the entire body organs. This part of the body therefore tends to burn more calories than any other part of the body. The exercises done on the legs assist to increase a way that testosterone as well as the other growth hormones can be released from the body. The working out of the legs support the strengthening of the lower and core back and in return makes the upper parts of the body workout better. The concept of working out legs is all mental and the through activating the behavior of working out legs ends increasing the strength of the mind.

Reducing the leg exercises decelerates the rate of production of new nerve cells. In addition, the oligodendrocytes as well as neurons, which are specialized cells are also produced in small quantities for failure to carry out leg exercises. These cells are used to insulate as well as support the nerve cells. The cells will not be able to fully mature if a person does not regularly engage in exercising the legs. The exercises undertaken by the legs predict the health of the brain better than any other kind of lifestyle factor. The power of the legs aids in predicting the cognitive capability or fitness of an individual. A great leg workout has been noted to improve many brain pathways as compared to other types of regular exercises. The

workout on legs can assist to improve the functions related to the various brain functions such as the memory, moods and learning.

The nervous system and the brain are the key drivers of the various functions that is undertaken by the body. Therefore, keeping their processes functioning in a healthy way is one of the critical undertakings that human beings need to do. The brain connects to the muscles of the body through the use of the motor neurons. The brain controls the muscles of the body through the motor neuron. The brain, though not a muscle, needs to be exercised and depends on the exercises undertaken by the rest of the body to maintain its health and maintain its proper functioning. Regular exercises speeds the flow of blood from the heart to the brain. The flow of blood to the brain increases the nourishment such as the delivery of nutrients and oxygen. This has been attributed to be the reason why exercising has been shown to increase the cognitive functioning of the humans. The legs have been shown to have the largest share of muscles than any part of the body. This means that they contribute greatly to exercising the brain through the motor neurons.

The physical exercises contribute to increases in cognitive functioning and reduces cognitive problems or challenges. Legs, having the majority share of the muscles among the various body parts, makes it more efficient in exercising the brain. Aerobic exercises such as those that are done using the legs increases the flow of oxygen to the brain. This minimizes the chances that the gray matter will be damaged in case of lack of oxygen or even low levels of oxygen, referred to as hypoxia. Aerobic exercises, mostly from the legs, give rise to the cerebral oxygenation, whereby, well oxygenated blood can flow to the brain and support it in its various functions. Exercises can be used to lessen the resistance of insulin, inflammation reduction, as well as fuel the release of chemicals that ensure the health of brain cells (Godman, 2018). From another point of view, exercises increase the need for rest or sleep. This creates a good atmosphere for reduced anxiety as well as stress. Both the medial temporal cortex and the prefrontal cortex are in great volume among the people who do regular exercises as compared to those who do not exercise.

CONCLUSIONS

Leg exercise represents a type of a lower body exercise that is intended for the muscles found below the waist of an individual. There are different types of leg exercises that vary from walking to running to cycling, among others. Where machine assisted or non-machine assisted, leg exercise plays a critical role to the general wellbeing of an individual and in particular the functioning and health of the central nervous system. Several studies have established that these diverse leg exercises are not only good for the toning of the muscle mass but also impact significantly to the health of the brain. Exercising the legs leads to production of new neural cells. This production of new nerve cell is essential in the proper functioning of the central nervous system as it is responsible for elements that allow humans to handle stressful conditions and manage life dynamics.

However, the studies used in the present research were found to be limited in content and context. For instance, the use of a homogenous groups in the research raises doubt as to whether the results can be generalized to other non-included groups. There is a need to include a heterogeneity to assess whether the results would be consistent.

REFERENCES

Adami, R., Pagano, J., Colombo, M., Platonova, N., Recchia, D., Chiaramonte, R., Bottinelli, R., Canepari, M., & Bottai, D. (2018). Reduction of Movement in

Neurological Diseases: Effects on Neural Stem Cells Characteristics. *Frontiers in Neuroscience*, 12.

Baek, S. (2016.) Role of exercise on the brain. *Journal of Exercise Rehabilitation*, 12(5), 380-385.

Barough, N. (2016). Walking for Fitness. New York: DK Publishing.

Bishop, T. (2011). Stronger Legs & Lower Body. Champaign: Human Kinetics.

Colcombe, S. & Kramer, A.F. (2003). Fitness effects on the cognitive function of older adults: A meta-analytic study. *Psychological Science, 14*, 125-130.

Cotman, C.W. & Berchtold, N.C. (2002). Exercise: a behavioral intervention to enhance brain health and plasticity. *Trends in Neurosciences, 25 (6)*, 295-301.

Deng, W., Aimone, J. B. & Gage, F.H. (2010). New neurons and new memories: how does adult hippocampal neurogenesis affect learning and memory? *Nat Rev Neurosci*, 11, 339–350.

Erickson, K. I., Raji, C. A., Lopez, O. L., Becker, J. T., Rosano, C., Newman, A. B., Gach, H. M., Thompson, P. M., Ho, A. J. & Kuller, L. H. (2010). Physical activity predicts gray matter volume in late adulthood: the Cardiovascular Health Study. *Neurology* 75, 1415–1422.

Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L., Kim, J. S., Heo, S., Alves, H., White, S. M., Wojcicki, T. R., Mailey, E., Vieira, V. J., Martin, S. A., Pence, B. D., Woods, J. A., McAuley, E. & Kramer, A. F. (2011). Exercise training increases size of hippocampus and improves memory. Proc. Natl. Acad. Sci. U.S.A. 108(7), 3017–3022.

Gapin, J. & Etnier, J. L. (2010). The relationship between physical activity and executive function performance in children with attention-deficit/hyperactivity disorder. J Sports Exercise Psychol 32:753–763.

Godman, H. (2018). Regular exercise changes the brain to improve memory, thinking skills. *Harvard health letter*.

Hamer, M. & Chida, Y. (2009). Physical activity and risk of neurodegenerative disease: a systematic review of prospective evidence. *Psycho Med*, 39 (1), 3-11.

Heo, Y. M., Shin, M. S., Kim, S. H., Kim, T. W., Baek, S. B. & Baek, S. S. (2014) Treadmill exercise ameliorates disturbance of spatial learning ability in scopolamine-induced amnesia rats. *J Exerc Rehabil*, 10, 155–161.

Kirk-Sanchez, N & McGough, E. L. (2014). Physical exercise and cognitive performance in the elderly: current perspectives, *Clinical Interventions in Aging*, 9, 51-62.

Lezak, M .D. (2004, M .D. (2004) Neuropsychological assessment (4th ed.). New York: Oxford University Press.

Muscolino, J. E. (2016). *The muscular system manual-E-Book: the skeletal muscles of the human body*. Elsevier Health Sciences.

Ohman, H., Savikko, N., Strandberg, T. E. & Pitkala, K. H. (2014). Effect of Physical Exercise on Cognitive Performance in Older Adults with Mild Cognitive Impairment or Dementia: A Systematic Review. *Dementia and Geriatric Cognitive Disorders*, 38, 347-365

Opel, N., Martin, S., Meinert, S., Redlich, R., Enneking, V., Richter, M., Goltermann, J., Johnen, A., Dannlowski, U., & Repple, J., (2019). White matter microstructure mediates the association between physical fitness and cognition in healthy, young adults**.** *Scientific Reports*, 9 (1)

Rovio, S., Spulber, G., Nieminen, L. J., Niskanen, E., Winblad, B., Tuomilehto, J., Nissinen, A., Soininen, H. & Kivipelto, M. (2010). The effect of midlife physical activity on structural brain changes in the elderly. *Neurobiol Aging* 31, 1927–1936.

Smith, P. J., Blumenthal, J.A., Hoffman, B. M., Cooper, H., Strauman, T. A., Welsh-Bohmer, K., Browndyke, J. N., Sherwood, A. (2010). Aerobic exercise and neurocognitive performance: a meta-analytic review of randomized controlled trials. *Psychosom Med*, 72, 239–252.

Yau, S. Y., Gil-Mohapel, J., Christie, B. R., So, K. F. (2014). Physical exercise-induced adult neurogenesis: a good strategy to prevent cognitive decline in neurodegenerative diseases? *Biomed Res Int*, 403120.

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Conflict of Interest

The author declared no conflict of interest.

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