KPE 190 assignment one-literature review

The effect of physical activity on cognitive function

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Physical activity (PA) is known to have numerous benefits to improve people's lives, but most researches mainly focus on benefits related to physical health. There is a plenty of evidence that PA can reduce the risk of type 2 diabetes, coronary heart diseases, obesity and many other diseases. However, whether and how PA can improve people's cognitive function is a relatively new area.

The earliest "pioneering study" on physical activities' benefits on cognitive function, according to Cox et. al, was conducted by Spirduso in 1975, who points out that "cognitive function in active, older adults was similar to younger adults and significantly better than inactive peers". (2015). Following study mainly focuses on how physical activity affect the brain function of children, whose brains are developing, and the elderly, whose brains are degenerating. PA's cognitive influence

among adolescents and young adults (AYA), from 12 to 24 years old, is vague. However, the brain is still developing during AYA period and it is golden age to acquire knowledge, when most people are working on their high school, college and postgraduate degree, and the pressure from study has significantly reduced exercise time during AYA's period. If PA can benefit AYA's cognitive function, performing PA is recommended for students to have development on their study career. Therefore, this literature review is to find evidence of the effect of PA on AYA's different cognitive functions.

The literature review was performed using the electronic database PubMed, combining terms of "physical activity", "cognition", "adolescent" and "young adults". ((("Young Adult"[Mesh]) OR "Adolescent"[Mesh]) AND "cognition"[Mesh]) AND "Exercise"[Mesh]. "Mesh" is used to include all the terms that have the same meanings with the terms above.

Articles are sorted with following criteria. First, the participants in the studies have to be male and female adolescents and young adults (from 12 to 24 years old). Second, the study has to be about the relationship between physical activity and cognitive

function. Finally, I want my research to be new and updated, so the articles I find have to be within the most recent five years. The initial search results are 570 research papers which are potentially related with the topic. Through scanning the title, 532 research papers are excluded with only 36 papers left. Then, 14 research papers are excluded for not dealing with the same age group people and another 9 research papers are excluded for being published more than 5 years ago. Finally, 13 research papers are left with four systemic review papers and 9 study journal articles.

Methods and overall effect of physical activity on cognitive function

These nine journal articles use different methods to test cognitive functions, with five conducting cognitive test, two testing serum neurotrophic factor directly and two testing with school performance.

For cognitive tests, they are mainly designed for testing the memory function and executive function. For example, Harveson et al. (2016) uses “Stroop Color and Word test” to test participators’ processing speed after acute physical exercises. In each test,

participants need to identify the colors on stimulus flash card ordered as dots, noncolored words and colored words. Ludyga et al. (2018) and Gejl et al. (2018) both applied a modified “Flanker task”, which required participants to “respond to the direction of a centrally presented target stimulus”, to test participators’ inhibitory control ability, which is a part of executive cognitive function. The benefits of using cognitive tests for cognitive function is that different kinds of cognitive function can be tested, and the results are quite straightforward. Also, testing serum neurotrophic factors is also applied for cognitive function, but it is mostly used for memory function. Researchers in the two articles both test brain derived neurotrophic factor (BDNF) and insulin-like growth factor 1 (IGF-1), which, according to Heisz et al., (2017), “can promote the survival, maturation, and maintenance of new cells” in the hippocampus. Hippocampus is responsible for the formation, retrieval and processing of memories, thus causing our brain functions more efficiently, like a larger CPU. (OIsen, Moses, Riggs& Ryan, 2012). Therefore, testing cognitive function, especially memory, with neurotrophic factors is more accurate. From the two tests, there is evidence that physical activity can increase BDNF and IGF-1, which means

increasing blood vessels supply in brains, gray and white matter density and size of hippocampus (Gaertner et al., 2018, P484-494), it reveals the result that our memory functions better if we do physical activity. Another way is to test with school performance. This method is not accurate or widespread, but it is really convenient rather than designing tasks or testing neurotrophic factors and it can be tested on a large amount of people.

Eight in nine journal articles discovered a positive connection between physical activity and cognitive function. For example, Harveson et al. (2016), in her article "acute effects of 30 minutes resistance and aerobic exercise on cognition in a high school sample", argues that "both acute resistance and aerobic exercise can significantly increase measures of cognition over a neutral-spinalis control in healthy high school students". Besides, Ludyga, Gerber, Brand, Puhse and Colledge also found that young adults who perform a running bout of moderate intensity have better inhibitory control as well as short-term and long-term memory in a classroom setting. The positive connection is also found in America (Harveson et al., 2016), Canada (Heisz et al. 2017), Switzerland (Ludyga et al., 2018), Netherlands (Van et al., 201e)

and Germany (Gaertner et al. 2017) However, one article failed to find enough evidence for the positive influence of school based physical activity intervention to students' executive functioning or mathematics skills. (Tarp et al., 2016)

Considering the amount of physical activity that can change the brain function, Jeon and Ha (2016) found that more aerobic exercise leads to better cognitive function, which means that people who do aerobic exercise for a long term and with higher exercise intensity can benefit more on their memory and executive functions. It is consistent with Gejl et al.'s research findings (2018) that higher intensity short bouts of exercise improve executive brain functions.

The effect of physical activity on memory

Six articles test the relationship between memory and physical activity, five articles show a positive relationship, while the left one does not find positive relationship. Van et al. (2014) made a research on the relationship between commuting to school and cognitive performance, which is tested with students' academic achievement

(Dutch, mathematics and English). However, they didn't find the improvement on memory with both males and females.

Among the five articles that show a positive relationship, in terms of different kinds of memory, the results are different. There are three articles discussing whether physical activity can be beneficial to working memory, which is "cognitive system's capacity for temporarily holding information available for processing" (Wikipedia). Two articles show a positive relationship between physical activity and working memory, but one article does not find evidence of this kind of relationship (Ludyga et al., 2018). However, Ludyga et al. (2018), the author of this article, explains that the possible reason might be biased selection of participators. Participators with high physical activity level already have higher working-memory performance, it is hard for their working memory performance to be higher with moderate aerobic exercise session. From the analysis above, the conclusion that physical activity can be beneficial to working memory is achieved. Besides, Gerber (2018) points out that only 8 months' physical activities can improve working memory, but it can only improve working memory maintenance rather than working memory accuracy. Since

the improvement of working memory maintenance can contribute to higher reaction time (Gerber, 2018), it is very important for academic performance.

There are five articles discussing whether physical activity can be beneficial to long term or short-term memory. Generally, there is positive effects on long term or short-term memory according to the four articles. More specifically, Heisz et al. (2017), in her article, argues that exercising can improve high interference memory performance. High interference memory performance is people's capability to memorize when a high interference exists. The reason why physical exercises can lead to better high interference memory is because of faster "turn over and regeneration of neurons", which can create "event-specific memory traces that reduce interference and increase distinction between the memory traces of highly similar events". (Heisz et al., 2017, P1895-1907) On the other hand, Carol (2014) shows that physical activity is only beneficial to hippocampal dependent relational memory but have no effects on non-hippocampal-dependent item memory. The research result is consistent with Heisz's research result, which means physical activity selectively

influence our brain function. It can be beneficial for AYA to identify and memorize the relationship between different items, such as their similarities and distinctions.

The effect of physical activity on executive function

Executive function "is a set of cognitive processes that are necessary for the cognitive control of behavior" (Wikipedia). Generally, six articles mention the relationship between physical activity and executive function. Five articles found a positive relationship, while one (Tarp et al., 2016) failed to find the evidence of physical activities' benefits on executive function. The method Tarp et al. used is different from the other four articles. He conducted the research in a high school base, asking teacher to assign homework about physical activity and sometimes arrange physical activities such as cycling and he uses students' academic performance (math test) as a method to test their cognitive function. The difference in methods of testing cognitive function and conducting physical activities between Tarp et al.'s research and the other four might be the reason of different research results.

Inhibitory control capability is a vital part in executive function, which is the “ability to focus on relevant stimuli in the presence of irrelevant stimuli”. Two journal articles talk about the relationship between physical activity and inhibitory control. These two results perform different physical activities for their tests. Gejl et al. (2018) mainly test short time acute exercises’ effects (five minutes), while Ludyga (2018) designed his physical exercises as a twenty minutes’ moderate intensity running exercises. However, both the two results found that modulate inhibitory control improves with the evidence of higher accuracy and shorter reaction time after physical activity. Therefore, both short period acute exercises and long period moderate exercises are beneficial to inhibitory control capability. According to the definition, higher inhibitory control capability can result in better concentration on relevant information, its temporary benefits may contribute to greater learning behaviors in real life.

Two articles in five find that physical activity have more benefits on executive cognitive function than memory function. Van (2014), in his article “active commuting to school, cognitive performance, and academic achievement: an observational study in Dutch adolescents using accelerometer”, claims that the

greatest benefits on cognition relating with commuting to school is executive function. While Gaertner et al. (2018) also found that the influence of physical activity on executive function is greater than associations with memory in the large nationwide population-based study in Germany.

Summary

This literature review examined the relationship between physical activity and cognitive function in adolescents and young adults, with age ranging from 12 to 24 years old. The age group's brain function is still developing and is on high level. At the same time, they have large knowledge acquisition during this period especially when pursuing high school, college and post graduate degree. This study identifies a small but recent nine journal articles.

The methods researchers use to test people's cognitive function can directly influence the research results. Among the three methods (cognitive test, school performance and serum neurotrophic factor), researches testing with serum neurotrophic factor results

in the most consistent study results, following with cognitive test. Test with school performance seems not to find enough evidence for the correlation. The possible explanation might be the fact that school performance can be influenced by many other variables, like knowledge base, hard work and study methods. Therefore, the importance of cognitive function like memory or executive function becomes weaker. Besides, it is hard to control the overall physical exercise level in a high school setting, making the research less accurate.

For study results, there is evidence demonstrating the positive relationship between physical exercises and cognitive function, including memory and executive function, and the influence on executive function is larger than memory function. Physical exercises with longer duration and higher intensity have greater advantages. When regarding to memory function, physical exercises have benefits on working memory, but mainly on working memory maintenance rather than accuracy. For long- and short-term memory, research shows that physical activity can mainly increase the relational memory (how things are related), but there is no evidence showing whether or not physical activity can increase the accuracy of memory. Using serum

neurotrophic factor for explanation, physical activity can increase number of hippocampal dependent relational memory rather than non-hippocampal-dependent item memory.

In terms of executive function, research shows that both high intensity short period exercises and moderate intensity long period exercises can be beneficial to inhibitory control function.

In conclusion, since physical activity can be beneficial to AYA's brain function, it is recommended that AYA performs long term moderate to intensity physical activities.

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