

Effects of Physical Activity on Academic Performance

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## Chapter I

### Introduction

The Centers for Disease Control and Prevention recommends that children get one hour or more of physical activity every day ([www.cdc.gov](http://www.cdc.gov), 1). In the past, forcing children and young adults to get an adequate bout of physical activity in a day was never a problem. In this day, it has become more of a struggle due to technological, economic, and social changes (Juneau, 2010, [www.hsph.harvard.edu](http://www.hsph.harvard.edu), 3). These changes have affected the methods of physical activity that were once very prominent in a child's daily routine. For example, a study done in 1969 showed that forty percent of children rode their bikes to school (Nader, 2008). A study done later in 2001, showed that only thirteen percent continue to ride their bikes to school (Nader, 2008).

The lack of physical activity in children's routines has caused many people to question whether it can have an effect on their cognitive growth. In particular, people have questioned whether physical activity can have an effect on academic performance. There have been two mechanisms thought to be the reason for improved academic performance when physical exercise is performed. The mechanisms are labeled as physiological mechanisms and learning/development mechanisms.

The physiologic mechanisms deal with bodily changes that are brought on by performing exercise. The Hippocampus is a portion of the brain located in the medial temporal lobe that is responsible for long term memory. Studies have shown that lifestyle choices can affect the plasticity in the Hippocampus (Monti, 2012). In particular it can be affected by physical activity.

Physical activity will increase the cerebral blood volume that is in the Hippocampus. When the blood volume is increased Neurogenesis occurs. Neurogenesis is a process where neurons become generated from neural stem and progenitor cells (Hannula, 2009). Studies have

shown that the formation of new neurons in the brain allows the child to continue adding memories to their brain and altering memories so they can be distinguished from one another (Sibley, 2003). The arousal levels in the body are also increased after physical exercise.

The learning and development mechanisms are based on studies showing that movement can stimulate cognitive development (Sibley, 2003). They hypothesize that movement aids and may even be necessary for proper cognitive development to occur in a child.

### Statement of Purpose

The purpose of this literature review is to examine whether daily physical activity does affect the academic performance of children and adolescents. In some areas it looks further in depth at different forms of physical activity and how each form can affect the outcome differently. Other studies that are presented throughout this review look at cofactors such as body mass index, age, socioeconomic status, etc and how they can affect the outcome as well. The goal of this literature review is to show the importance of regular physical activity in children and adolescents.

### Significance of the Study

Due to the decrease of physical activity, many people have begun to question the effects it may have on the well being of children and adolescents. In the 1970s physical education classes became very popular in school systems due to the need for the physical benefits students get (Sibley, 2003). In 2000 a study done by the School Health Policies and Programs stated that, “the percentage of schools that require physical education in each grade declines from around 50% in grades 1 through 5, to 25% in grade 8, to only 5% in grade 12.” This study also stated

that only 8% of elementary schools provide daily physical education courses for their students and only 6% of middle/high schools provide daily physical education courses (Sibley, 2003).

Although there are many teachers and schools putting physical education courses on the sidelines of their curriculum, there are also many educators who believe physical education is an imperative part to their student's daily learning. Many teachers see an impact in their student's concentration, learning ability, and all around academic success when they engage in physical activity (Sibley, 2003).

#### Delimitations

- Many of the studies used were not long term.
- The studies examined the same age group, which was generally middle school aged children.

#### Definitions

- BDNF: Brain Derived Neurotrophic Factor (BDNF) is a secreted protein that is encoded by the BDNF gene.
- Body Mass Index (BMI): assessment of whether a person is overweight or underweight. Calculated by dividing body weight in kilograms by height in meters squared.
- Caliper: instrument for measuring thickness or distances between surfaces.
- Calorimetry: measurement of heat
- Dementia: loss of or damage to the neurons in the brain which causes severe impairment or the loss of intellectual capacity and personality integration.
- Dynamometer: device for measuring mechanical power or force.

- Dynamometry: the science of power measurement.
- Electroencephalography (EEG): recording of electrical activity along the scalp.
- Ergometer: device designed to measure power of muscle.
- Event-Related Brain Potential: brain response to sensory, cognitive, or motor event.
- Magnetic Resonance: the response to radio waves or forms of energy by atoms, molecules or nuclei that are subjected to a magnetic field. This is commonly used medically for scanning.
- N400: part of the brain response toward words and meanings including pictures, faces, sounds, smells, visual, and auditory words.
- Neurogenesis: formation of nervous tissue.
- P600: triggered by hearing or reading errors in grammar and other syntactic violations.
- VO<sub>2</sub>: maximum rate of oxygen consumption. (Coe, 2006)

## Chapter II

### Literature Review

The idea that physical activity can affect the ability for a child to hold memories better, should be a positive reason for parents and educators to promote physical activity in children's daily lives. There is so much emphasis and pressure put on people to be smart and excel in school. Due to that, the question of whether participating in more physical activity will help children get better grades in school has arisen over the years.

#### Studies Focusing on Hippocampus

In 2010, a study was published that researched whether exercise training would improve memory by increasing the size of the hippocampus (Erickson, 2011). The researchers used a single-blind randomized study in which 120 older adults, who were diagnosed with dementia, were evenly split into two groups. Each group either performed moderate-intensity aerobic exercise or toning/stretching exercises three days per week (Erickson, 2011). The toning and stretching exercises were considered to be the control. The study used magnetic resonance images to assess the size of the hippocampus before the program started, six months into the study, and once the study was complete. The results of this study showed that the size of the hippocampus can change through moderate intensity aerobic activity at least three days per week. They found the anterior hippocampus volume increased from baseline to after intervention on the left side 3.38 with  $P < 0.001$  and the right side 4.33 with  $P < 0.001$ . They also found that the specific area of the brain targeted was the anterior hippocampus. This study is a good representation of how the hippocampus, which functions for spatial memory, is positively affected by physical activity.

As shown, research of the hippocampus can be an important factor in determining the effect of physical activity on the brain. Due to its importance, there was more research done in 2012 (Monti, 2012) that looked closely at the relationship that memory plays. In this particular study there were twenty five children who participated in the exercise intervention group and nineteen who were part of the control group. The exercise group participated in an after school program called Fitness Improves Thinking (FITKids) for nine months. They participated in a healthy snack, healthy education, forty to sixty minutes of physical activity, and games that centered on a specific skill (Monti, 2012).

The students also performed a memory test that involved six trials of viewing images (Monti, 2012). The children had to pick which of the three faces went with a scene. Since all of the faces and scenes had been previously viewed by each child, they needed to rely on relational memory in order to identify the correct face to each scene. The eye movement data was measured by the time a child spent viewing the correct face in comparison of the time viewing all three faces in that trial (Monti, 2012). Their results showed that the aerobic exercise group increased their  $VO_2\text{max}$  from 20.8 to 29 with a  $p < .05$  after the intervention. This study found that the hippocampal activity was able to predict the viewing time the child would have to pick the correct face. The aerobic exercise intervention showed hippocampal dependent relational memory in their eye movement measures, which shows that memory is strengthened with aerobic exercise.

This literature review examined one other brain related study that was done recently in 2014. It examined language processing in relation to aerobic fitness (Scudder, 2014). They specifically looked at event-related brain potentials (ERPs), which provided them with the brain's response during engagement. The study presented children with a series of sentences that

were either normal or contained semantic or syntactic violations. They had to use a response pad to state whether they thought the sentence was correct or had violations (Scudder, 2014). Each child had their electroencephalographic activity monitored to assess the amplitudes of N400 and P600 in their brain during engagement. The children also participated in a VO<sub>2</sub>max test to determine aerobic fitness. The results showed the children who were more fit had better reading achievement scores with a mean of  $123.1 \pm 2.8$  and the lower fit children had a mean of  $112.9 \pm 2.1$  on their scores with a p value of .007 for both. The results were spelling achievement scores were similar with higher fit children scoring a mean of  $117.6 \pm 2.6$  and lower fit children scoring a mean of  $108.0 \pm 3.0$  with a p value of .02 for both values (Scudder, 2014).

#### Physical Activity Focused Studies

It is important for people to be involved in a regular physical activity routine in order to keep their body and mind healthy. Past evidence has shown that physical activity and its positive healthy attributes are seen most in adults. However, research (Tremblay, 2000) has also shown that an adult is more likely to exercise if it was first established in their youth as a priority to their health. Unfortunately, physical activity being a standard part of childhood is slowly dwindling in school systems due to many people believing that it affects their academic success negatively (Tremblay, 2000). The following research studies have put their focus on the idea that physical activity can improve academic success in children and adolescents.

In 1996, a study was done that looked specifically at twelve year old children and the relationships between physical activity, self esteem, body mass index (BMI), and academic achievement (Tremblay, 2000). The study included 5,146 students who began by filling out a questionnaire (Tremblay, 2000). The data from the questionnaire was then collected and

compared to the students standardized testing scores. They found that students' who were in smaller families or two parent families were found to be less physically active rather than larger families. They also found that girls reported less physical activity than the boys. They found that the self esteem was positively influenced by the student's socioeconomic status. Overall, girls showed lower self esteem than the boys and children in smaller families showed lower self esteem than children in larger families. However, they found that self esteem was significantly related, in a positive manner, to physical activity levels in students (Tremblay, 2000). The math and reading scores were then analyzed and when combined with other data showed that students who had higher self esteem were seem to perform better in their math and reading scores (Tremblay, 2000). Based on  $p < .001$  for every standard deviation in socioeconomic status the students physical activity level increases by .4 units. The final piece of data that they analyzed was the body mass index (BMI). Their data found that the students who had a high socioeconomic status were eighty percent as likely as an average socioeconomic status child to have a high BMI. They also found that a ten percent reduction in BMI was seen in students who had regular physical activity (Tremblay, 2000).

As noted in the previous study, there is importance in examining different factors such as BMI and socioeconomic status when determining the effect that physical activity will have on academic performance. Not only are those factors important, but it is also valuable to examine the type of physical activity being done. A study published in 2001, examined many different types of physical activity (Dwyer, 2001). The study used a large sample of 9,000 students in Australia who were between the ages of seven and fifteen years old (Dwyer, 2001). The activity tests were split between indoor and outdoor groups. The indoor group was as follows: standing long jump, sit ups, pushups, sit and reach, dynamometry, skin folds, lung function, and height

and body mass measurements (Dwyer, 2001). The outdoor portion of physical activity was done after the indoor and included a 50 meter sprint and a 1.6 kilometer run (Dwyer, 2001). The following day, the 9, 12, and 15 year olds completed a test on a Monark cycle ergometer that required them to perform three ascending power outputs that each lasted three minutes long.

There was also a questionnaire given to the students who were 9 years of age and older. The significant results showed that students who had higher academic scores took less time to complete the 50 meter run and they were able to complete more sit ups and leap greater distances in the standing long jump. They did find some differences in relation to gender and age, but overall there was a correlation found between academic performance and physical activity. They also did not find any particular age or gender relationship with a specific exercise that showed more improvement in academic performance. They noted that overall all of their measures including, cardiorespiratory endurance, muscular force, power, and physical activity in general showed a relationship with academic performance.

Researchers are finding that not only is it important to examine the type of activity, but also how much activity needs to be done to show any change in academic performance. A study done in 2006 involved 214 students who were in the sixth grade (Coe, 2006). They were all assigned to a physical education course during either the first or second semester of the school year. The students were also assessed on their moderate and/or vigorous activity that they participated in outside of school. The assessment was done with a three day recall. Their activity was given numbers to identify the amount. The numbers included, 1 being no activity, 2 being some activity, and 3 being enough activity to meet the guidelines of the Healthy People 2010 (Coe, 2006). Their academic achievement was assessed in four core classes and their standardized test scores. They found that students who identified with having vigorous activity

that met the guidelines for Healthy People 2010 had higher grades than the students who had no vigorous activity (Coe, 2006). Significance was found in the vigorous physical activity category with  $x^2 = 10.0$ ,  $df = 2$ ,  $p < 0.006$  in the first semester. In the second semester they found significance again with vigorous activity with  $x^2 = 6.05$ ,  $df = 2$ ,  $p < 0.049$ .

Many teachers have shown concern over the concentration abilities many of their students struggle with on a daily basis (Budde, 2008). This concern led to a study done in 2008 that looked at 115 adolescents between 13 and 16 years of age. They were all members of an elite performance school and were then randomly assigned to either an experimental or control group (Budde, 2008). For the academic performance portion of the test students performed a d2-test, which determines how well they could focus on one stimulus while avoiding distractions (Budde, 2008). The purpose of the test was to measure visual perceptual speed and capacities in concentration. Each test subject then participated in exercises from the Munich Fitness Test and training programs for soccer. These exercises measured different bilateral coordinative abilities such as balance, and ability to react and adjust to situations (Budde, 2008). They found that all students who participated improved their performance on the d2 test from the pre-test to the post-test due to practice and less errors made by the students in both the control group and experimental group. However, they found a difference in the pre and post test improvements between the control group and experimental group. The results showed that the experimental group improved much higher than the control group did (Budde, 2008). The students who participated in coordinated exercise before taking the test did show a higher degree of improvement (Budde, 2008).

One study examined data from the Early Childhood Longitudinal Study, which looked at the Kindergarten class from 1998 to 1999. There was a total of 5316 students analyzed (Carlson,

2008). The researchers measured physical education and academic achievement. The amount of physical education was reported by teachers throughout the week. They would give a number such as never, <1, 1 or 2, 3 or 4, or daily that they exercised per week. The students were then broken into three groups based on how many minutes per week they did physical education (Carlson, 2008). The students were then tested on their academic achievement portion of the study. The IRT estimates the probability of correct responses for all the questions on the exam, but each student was only given some of the questions. When comparing students ranging from Kindergarten through fifth grade they found that only girls who had high physical education scored a mean of 2.4 points higher on the IRT reading assessment and 1.5 points higher on the IRT mathematics assessment (Carlson, 2008). This however, had no correlation with grade level or the type of activity they participated in.

In 2014 a study was conducted in Taiwan that examined how academic performance was affected from daily energy expenditure (Wang, 2014). There were 1065 children who ranged from grades 4<sup>th</sup> through 6<sup>th</sup>. Each student participated in a three day physical activity recall which allowed them to determine their mean energy expenditure. Their amount of physical activity was categorized as either lowest physical activity, middle physical activity, or highest physical activity. The results showed a significant positive effect on academic performance with all students who were in the middle PA group. They also found that male groups performed better in the middle PA group and females performed better in the lowest PA group (Wang, 2014).

Short bouts of high intensity exercise have also shown to affect how well a student focuses. One study done (Ma, 2014), looked at students in grade 4 and grade 2 for three weeks. The study allowed students a break from activities during the day. Some students had no activity break and others were given a break that consisted of what they called “FUNtervals” on

alternating days during the week. The no activity break was a ten minute break where they did no activity. The FUNterval break was 4 minutes of activity, followed by ten minutes of no activity. Each student's behavior was recorded for 50 minutes following their break in order to determine how much time they spent off task. The results showed that the 2<sup>nd</sup> and 4<sup>th</sup> grade students had less off task behavior when they participated in the high intensity bouts of exercise (Ma, 2014). The passive off task behavior decreased by 9% with no activity being  $23\% \pm 14\%$  and the FUNterval group being  $14\% \pm 10\%$  with a p value of  $<0.01$ . They also assessed the verbal off task behavior and found there to be a 3% decrease with the activity group. The group that did not participate in activity was  $8\% \pm 8\%$  and the FUNterval group was  $5\% \pm 5\%$  with a p value of  $<0.05$ . The final form of off task behavior they assessed was motor. They found the no activity group to be  $29\% \pm 17\%$  and the FUNterval group was  $14\% \pm 10\%$  with a p value  $< 0.01$ .

A study done in 2014 used a random sample of second and third grade students (Scudder, 2013). Each child's aerobic fitness was assessed using a test called the Progressive Aerobic Cardiovascular Endurance Run (PACER) where the students ran laps. They were considered higher in fitness level with the greater number of laps they were able to complete in the allotted time frame. The PACER is generally used as a fitness test to determine the ability of a person to keep a steady pace, which requires a person to be in good physical shape. The flanker test was used to determine cognitive control and reaction time, in which the students had to look at pictures of gold fish and press a button determining if they were facing left or right. They also performed a memory exam in which they had to answer questions based on what they remembered. The results showed that children who were more aerobically fit had greater reaction time and accuracy in the flanker test. The memory exam also showed similar results with the fit

children being more accurate as their memory demands were increased during testing (Scudder, 2013).

A physical activity intervention program was completed in one study to see how it affected academic performance in fifth grade students in Sweden (Kall, 2014). They used a controlled cross-sectional design where one school participated in a physical activity intervention program and their academic scores were compared with three other schools who were not involved in a physical activity intervention program. The academic performance was based on their national learning goals that are set for their school system in Swedish, mathematics, and English. The results showed that more students who were participants in the intervention program scored higher in all three subjects than students who were not in the program did. The statistics showed that students in the intervention program had a two fold increase in the probability that they would achieve the national learning goals (Kall, 2014).

In some cases, researchers have examined the incorporation of physical education classes into the school's daily schedule to see if there is a positive change in academic performance. An example of this was completed in 2014. The study focused on 1,271 fifth and ninth grade children from Santiago, Chile (Correa-Burrows, 2014). Each child measured the amount of physical activity they performed, which included scheduled activities. Their academic performance was also measured based on their language and mathematics scores. The amount of exercise and academic performance was compared to the set standards by the Ministry of education. They found that eighty percent of the students were not very engaged in their scheduled exercise at school (Correa-Burrows, 2014). Specifically they found 14% of the students who were physically active to be male, 15% of students attended a school that had high academic standing, and 16% of students were of high socioeconomic status. The study found that

if the students had more than four hours of scheduled physical activity per week, their academic performance increased. The fifth grade students who performed a mean of  $7.1 \pm 3.1$  hours of activity per week had a raw math score of  $297.6 \pm 57.1$ ,  $p=0.006$  and a raw language score of  $293.1 \pm 59.8$ ,  $p=0.019$ . In comparison the fifth graders who performed a mean of  $3.1 \pm 0.6$  hours of activity per week had a raw math score of  $285.1 \pm 60.1$ ,  $p=0.006$  and a raw language score of  $290.5 \pm 66.8$ ,  $p=0.019$ . The ninth grade students also showed a similar comparison. The ninth grade students who performed a mean of  $7.1 \pm 3.1$  hours of activity per week had a raw math score of  $319.3 \pm 49.1$ ,  $p=0.000$  and a raw language score of  $301.0 \pm 44.2$ ,  $p=0.000$ . The ninth grade students who performed  $3.1 \pm 0.6$  hours of activity per week had a raw math score of  $302.9 \pm 50.7$ ,  $p=0.000$  and raw language score of  $282.8 \pm 46.9$ ,  $p=0.000$  (Correa-Burrows, 2014).

These results show that there is a correlation between amount of physical activity and academic performance in some areas.

A study done in Texas in 2011 used a random sample of 254,743 children ranging from grades 3 to 11 (Van Dusen, 2011). Texas has a standardized test called the Texas Assessment of Knowledge and Skills (TAKS) that they use for students in grades 3-11. The test examines how students perform in reading, writing, math, science, and social studies. In order to determine their fitness level they used a system called Fitnessgram. The fitness results were collected and grouped based on age and gender. After adjusting for socio-demographic covariates, the results showed that all fitness variables examined showed a positive response to academic performance except body mass index. The effect that physical activity had on the TAKS assessment ranged from means of .07 to .34. They also found that cardiovascular fitness in particular was shown to have a high effect on academic performance with scores ranging between 32 to 75 points higher than students who were not physically fit.

With all of the research being done on the correlation between academic achievement and physical activity there is one point that many people are trying to uncover which is, how much physical activity actually needs to be done to show a positive response. A study done in 2009 focused on that topic when doing their research (Hillman, 2009). They worked with 20 preadolescent people to see how just 20 minutes of walking on a treadmill would affect their academic performance. Each student walked at 60% of their estimated maximum heart rate for 20 minutes. After the treadmill, researchers monitored the children's heart rate until it was within 10% of their resting heart rate. Once they reached 10% or less, they performed cognitive assessments (Hillman, 2009). Each student also took the same assessments at a different time at rest. The results showed that there was an improvement  $t(1,19) = 2.6$ , with a p value of .016 in reading performance after they performed physical activity compared to resting. In particular they found that only reading showed significance based on the following values reading:  $d=.59$ , spelling:  $d=.16$ , and arithmetic:  $d=.06$ . Their data helps promote the idea that even a small amount of exercise can make a positive impact on academic performance.

The amount of time it takes to complete a study can play a huge role in the results that are found and how accurate they are. Most often studies that are done over a longer period of time are found to be more accurate. One study done in 2013 looked more closely at physical change over time and how it affects academic performance (Chen, 2013). The study involved 669 seventh grade students from a Taiwanese junior high school. The researchers examined the students until they were in the ninth grade. They collected academic grades from each class at the end of every school year. To determine physical fitness they collected cardiovascular fitness data, sit and reach flexibility data, and bent leg curls data at the beginning of each school year. They also assessed the height and weight of each student in order to determine BMI (Chen,

2013). The results determined that an improvement in cardiovascular fitness significantly affected academic performance in a positive manner. However, they found that improved muscular endurance and flexibility had no positive correlation with academic performance (Chen, 2013). They also didn't find any significance in the relationship between the student's academic performance and BMI. This study promotes the idea that cardiovascular fitness is a significant factor in improving academic performance.

## Chapter III

### Overall Findings of Literature

After viewing many studies that targeted whether there is a correlation between physical activity and academic performance, the overall findings show that there is a correlation present. The findings of studies that look at a more biological perspective have found that the hippocampus in the brain is the particular area that can be targeted through physical activity. The hippocampus plays an important role in spatial memory, which is crucial to academic performance. Some research shows that the size of the hippocampus can be positively changed through moderate intensity aerobic activity at least three days per week (Erickson, 2011). Another form of research used an aerobic exercise intervention and examined subjects through their eye movements when shown images that they had previously seen (Monti, 2012). The subjects who completed the aerobic exercise portion showed faster eye movement measures when identifying the images that were familiar to them. This showed that the hippocampus was increased in size and strengthened through exercise.

There were many other studies (Sibley, 2003, Carlson, 2008, Monti, 2012, Dwyer, 2001, Coe, 2006) that were examined throughout this paper that looked specifically at physical activity and its role in altering academic performance. Some studies also looked at underlying factors such as socioeconomic status, self esteem, age, BMI, etc. However, all underlying factors were examined closely in the analysis of data to determine if those factors made a difference in the conclusion. In all cases, those factors did not affect the outcome of the correlation between physical activity and academic performance.

One area that was closely examined was self esteem and its correlating factors including BMI and socioeconomic status (Tremblay, 2000). They found that physical activity positively altered these factors so that students had higher self esteem and lower BMI. They also found that students who had higher self esteem performed better in math and reading scores. This study showed that physical activity not only increases spatial memory through the hippocampus, but it can positively alter cofactors such as self esteem, BMI, etc to improve the student's academic success.

Other research focused more closely on physical activity without examining cofactors. One such study looked at a larger population of students and found that students who had higher academic scores showed greater skill and performance in physical activity tests (Dwyer, 2001). Another study similar to this had students participate in exercise and fitness tests (Budde, 2008). In this study, students completed a standardized test and then later took the test after a ten minute bout of exercise. The goal was to see if they would perform better on the test after having completed exercise. The results showed that students who participated in a ten minute bout of physical exercise showed more concentration and improvement on the test.

The idea that even small bouts of physical activity can make an improvement in academic performance is a great incentive for schools and parents to promote physical activity in their child's daily lives. If a child can improve their academic performance in just a ten minute bout of exercise that could be completed in between classes or at recess periods, then students should be incorporating time into their daily schedules. Not only were ten minute bouts of exercise studied, but another study looked at the effect a 20 minute bout of treadmill walking would have on academic performance. They found that the students performed better after the treadmill walking than they did on the same assessments after rest.

Not only is the amount of exercise an important factor to examine, but the intensity of the physical activity is also vitally important. The intensity of the exercise plays a role in its effect on academic performance. One example of this (Ma, 2014) had students participating in a program where they performed quick bouts of high intensity exercise to see how it would affect their concentration and “off task” behavior throughout the school day. They found that the students who participated in the exercise had less off task behavior. This study strengthens the idea that children can focus better if they are given moments of physical activity throughout the day, which enforces the need for physical education courses and recess periods.

With the idea that intensity is an important factor in determining whether physical activity can improve academic performance, researchers (Coe, 2006) found that students who had some activity did show improvement in their grades, but not to the extent that the children who participated in vigorous activity experienced. Only students who met the Healthy People 2010 Guidelines (Coe, 2006) for vigorous activity had significantly higher grades.

School systems cutting out physical education classes in order to budget has become more common over the past few years. A series of schools in Chile (Correa-Burrows, 2014) focused on the impact that a set physical activity class can have in a school system. They used a structured physical activity program that involved the children being active at least four hours per week. They found that the language and mathematics performance were improved with the increase in physical activity. They strongly emphasized that a program is needed at schools that will give children a structured amount of physical activity per week. In the case of this study they found that amount to be four or more hours per week. This study supports the need for physical education and health promotion courses to be taught in school systems.

So far the idea of intensity and duration were examined and found to be important factors in the correlation between physical activity and academic performance. However, the type of exercise has also been examined to see if there is a type that shows more of a positive connection. This was done over a two year period and assessed the same students throughout those two years. They were examining the relationship between cardiovascular fitness, muscular fitness, and flexibility to academic performance. They found that cardiovascular fitness was the only factor to have a positive impact on academic performance (Chen, 2013).

Overall, the studies discussed in this review have shown a positive correlation between physical activity and academic/cognitive performance. Many of the studies showed a positive impact with small amounts of physical activity. For example one study showed that just 10 minute bouts of exercise had an effect on academic performance (Budde, 2008). Another study showed that just exercise three days a week could have an effect on academic success (Erickson, 2011). This shows that even small amounts of physical activity can play an important role in the health and success of children and adolescents.

### Summary

The purpose of this literature review was to examine studies that have been published to find a correlation between academic success and physical activity. The dwindling amount of physical activity that children and adolescents are partaking in has become a concern for our society. The literature examined in this review is a good example of the research currently being done to help promote physical activity in school and at home. The importance of daily physical activity is shown through these studies due to the academic improvements that were identified.

## Chapter IV

### Recommendations for Further Research

It is recommended that more long term studies be done on this subject. The short term studies that were discussed throughout this literature review are showing positive results, however, studies that are more in depth will show stronger results. One study (Sibley, 2003) suggested that intervention studies that include valid and reliable dependent measures are needed to provide data on the actual amount, intensity, etc. of physical activity is needed to see these academic changes.

Many of the studies throughout this review involve student's activity levels at school and/or at home. The results of these studies could be altered based on economic factors such as socioeconomic status. It is important to note that many children who are of low socioeconomic status are more likely to have less access to physical activity. Without factoring in the socioeconomic status of each student, it is possible for the results to be inaccurate.

This study (Sibley, 2003) also put focus on the issue of identifying the bodily mechanisms that provided a positive relationship between physical activity and academic performance in order to strengthen the results being found. Another study (Budde, 2008, Monti, 2012) also brought attention to the idea of performing more neuropsychological function assessments throughout testing in order to know if cognitive function truly is changing and altering with physical activity.

Another study (Carlson, 2008) discussed inaccuracy of data in some situations. For example, when a teacher or student had to report their physical activity over the last seven days it is not positive that the data is correct. This study stated that if they had more accurate numbers in

these areas they may find more striking results. A form of data collection that would allow for complete accuracy in this area would be helpful in determining the exact amount of time and intensity for physical activity that is needed in order to see results.

One study (Monti, 2012) used VO<sub>2</sub>max tests to determine their results. Their participants were all children who were physically fit before beginning the assessments. Due to that, they all provided VO<sub>2</sub> max scores that were very similar to one another. The researchers determined that if they had a larger range of VO<sub>2</sub>max scores, they could further their proof on the effects that aerobic exercise has on memory capabilities.

## Chapter V

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