

Summer 8-8-2017

Will physical activity increase academic performance?

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Will physical activity increase academic performance?

A Synthesis of the Research Literature

A Synthesis Project

Presented to the

Department of Kinesiology, Sport Studies, and Physical Education The College at
Brockport

State University of New York

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Education

(Physical Education)

by

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July 22, 2017

THE COLLEGE AT BROCKPORT
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BROCKPORT, NEW YORK

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Title of Synthesis Project: Will physical activity increase academic
performance? A Synthesis of the Research Literature.

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Date: August 8, 2017

Accepted by the Department of Kinesiology, Sport Studies, and Physical Education,
The College at Brockport, State University of New York, in partial fulfillment of the
requirements for the degree Master of Science in Education (Physical Education).

8/17/17
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ABSTRACT

The purpose of this synthesis project is to collectively assess and analyze the critical mass of research articles to determine if physical activity can increase academic performance. The studies that met the inclusion criteria of examining the effects of physical activity on academic performance were included in this project. The articles were analyzed by using a synthesis grid, which helped to organize and examine the methods, results and discussions. Themes, such as effects on executive functioning, effects on academic core subjects and weekly hours, were accumulated from the articles. Based upon the critical mass; the results indicate that there can be a positive relationship between physical activity and academic performance. From this, discussion points were concluded examining grade level differences, advocating for physical education, comprehensive school physical activity program, after school sport participation, limitations and recommendations for future research.

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CHAPTER 1

INTRODUCTION

Physical activity has many benefits on the mind and body. Physical activity is known for increasing heart rate and the blood flow throughout the body, which gives the brain more blood to create energy and work more efficiently. When the brain works more efficiently, executive function is increased. Executive function is comprised of three core skills: working memory (most basic and fundamental concepts required for learning), inhibitory control (supports self-directed classroom behaviors), and cognitive flexibility (thinking skills) (Dalziell, Boyle, & Mutrie, 2015). Executive function has been linked with learning and academic achievement. Taking this all into account, it appears that there may be a connection between physical activity and academic performance.

Unfortunately, due to budget cuts and a focus on “core academic subjects”, physical education has been removed from schools. School administration puts more emphasis on classroom preparation for standardized tests, than promoting physical activity (Sibley & Etnier, 2003). According to the American Heart Association (2015), there has been a decline in physical education in recent years. Twenty two percent of schools do not require students to take any physical education at all. In addition, the Center for Disease Control and Prevention (1999) identifies that most American students do not participate in daily physical education and this trend is continuously declining over time.

Although there is a decline in physical education, there has also been a recent push for the Comprehensive School Physical Activity Program (CSPAP), which focuses

on integrating physical activity before, during and after school. Integrating physical activity into the classroom may increase student's physical activity time and have a positive affect on the student's academic performance. The more physical activity a student participates in, the more likely the student will be able to concentrate and remember material in class. Therefore, the importance of physical activity is becoming more common and recognized as a positive tool to increase academic performance. Teachers can incorporate physical activity into the classroom by taking the students outside or have students perform some type of physical activity in between lesson activities. This will help aid students to be more physically active, which in relation may increase a student's academic performance.

Thus, the purpose of this paper is to discover if physical activity can increase a student's academic performance. The hope is that if physical activity can increase academic performance, then physical activity should be integrated more into and after school. Therefore, physical activity should be treated and promoted as an important component to daily education.

Operational Definitions

Physical Activity. Any bodily movement produced by skeletal muscles that requires expenditure including, but not limited to, playing, walking, household chores, gardening and dancing through physical education class, classroom PA breaks and recess (World Health Organization, 2017).

Academic Performance. Factors, such as standardized test scores and grades, which influence the success of a student in school (Center for Disease Control and Prevention, 2010).

Executive Function. Higher-level cognitive functions that manage other more basic functions in order to achieve a goal (Benzing et al., 2016).

CHAPTER 2

METHODS

The studies included in the critical mass of this synthesis project were ones that examined physical activity and student's academic performance. In these studies, the methods comprised of either physical activity interventions or examination of physical activity hours.

Search Procedures

The search was conducted using the Academic Search and SPORTDiscus online databases through the Drake Memorial Library at The College at Brockport, State University of New York. The initial search terms were “physical activity and academic performance” and “physical education and academic performance”, which yielded roughly 1,097 and 2,019 articles, respectively. In order to narrow down my search, I focused my search on specific information related to my topic. “Comprehensive school physical activity program” search term was used to find classroom physical activity interventions, which returned 917 articles. The search term, “executive function and physical education” was used in direct relation to discovering physical activity and the effects on the brain with academic performance, which generated about 449 articles. In order to narrow down the articles received, the search terms, “physical activity and academic performance and classroom” was used and generated 81 articles.

The articles used ranged from the year 1997 to 2017, with the majority of the articles between the years 2014-2017. An additional procedure, called the ancestry

method, was used to identify articles for the critical mass by looking at the references of the systematic review (Marques, Gomez, Martins, Catunda, & Sarmento, 2017.) Six articles were discovered. In order to search for the articles on the database, the title of the article was used in the search tool.

Inclusion Criteria

The articles selected for the critical mass focused on studies that examined the effects of physical activity on academic performance. The methods section of the articles needed the study to focus on either a physical activity intervention or an analysis of weekly hours. The participants consisted of students in elementary, middle and high school. The measure of academic performance had to look at either executive function or core academic subjects.

Data Analysis

The physical activity interventions and weekly hours were organized by dependent variable, then put into two categories: effects on executive functioning and effects on academic performance. The articles were then divided into the intervention or weekly hours category. A synthesis article grid was used to extract relevant information from the articles. The use of the article grid helped the organization of the paper in order to develop themes for the results sections. The authors' conclusions helped further develop the results and discussion sections. The articles are comprised of quantitative data, which helped the compare and contrast of data.

CHAPTER 3

RESULTS

This section offers the reader with research results from the critical mass on the effects of physical activity on academic performance for students. The hope is that if physical activity can increase academic performance, then physical activity should be integrated throughout the school day and be treated as an important component to daily education. The results are organized into the following sections: effects on executive functioning, effects on academic core subjects and weekly hours.

Effects on Executive Functioning

According to Benzing and colleagues (2016), executive function is essential for academic achievement. Executive functioning is comprised of aspects such as working memory, that non-verbal and verbal ability, abstract reasoning, spatial ability, numerical ability, phonological awareness, and segmentation abilities, which contribute to a student's academic performance.

In one study, which added to the regular physical education program, two elementary schools in Scotland were randomly assigned to a control or intervention group (Dalziell, Boyle, & Mutrie, 2015). The intervention group participated in a 16-week program using Better Mover Thinkers, which is an approach within physical education that is designed to develop the ability to move and think, whereas the control group attended regular physical education classes. The intervention group significantly improved overall score changes in measures of working memory, phonological awareness and segmentation abilities. Working memory is one of the most basic and fundamental concepts required for learning, therefore, an important aspect of academic performance.

Another study analyzed the effects of a physical activity program on student's physical fitness and executive function. The study was performed on students from three primary schools, in which 53 students were in the intervention group and 52 students were in the control group (Van der Niet, et al., 2016). The intervention group participated in a 22-week physical activity program for 30 minutes during lunch, twice a week. The control group continued their normal lunch routine. The results indicated that the intervention group showed significantly higher improvement on inhibition and verbal working memory skills.

In one study that added additional physical activity to the school day, 35 average developing children, in 3rd and 5th grade, completed a session of either 10 minutes of physical activity integrated with math problems or seated math problems (Vazou, & Smiley-Oyen, 2014). The students who completed the 10 minutes of physical activity integrated with math problems had an improved response time in the Standard Flanker that assessed executive function components by having the students play a computer game to "feed" hungry fish by positioning the fish on either side. The authors indicate that this research can help support a strategy for promoting physical activity in order to facilitate executive function performance after the integrated physical activity.

The last study examines the effects of physical activity on both cognitive performance and academic achievement by adding to physical education classes (Arday et al., 2013). Sixty-seven 12-14 year old students were randomly assigned to either a control group or two intervention groups. The study lasted four months, with the control group (CG) receiving two physical education sessions per week, one intervention group (EG1) receiving four physical education sessions per week and the other intervention

group (EG2) receiving four physical education sessions per week of high intensity. The results indicated that non-verbal and verbal-ability, abstract reasoning, spatial ability and numerical ability all increased more in EG2 than in CG. Also, student's average school grades, in mathematics, increased more in EG2 than in CG. Therefore, EG2 improved the most in cognitive performance and academic achievement suggesting that the intensity of physical sessions might be of importance in the positive effect of physical activity.

Effects on Academic Core Subjects

Executive functioning contributes to more general aspects of academic performance, such as working memory and abstract reasoning, which may improve academic performance for specific subjects. The interventions below will represent studies that looked at physical activity as interventions as a way to improve scores on certain academic subjects. From the results included in this paper, mixed findings were concluded about the effects of physical activity into the school day.

A school-based intervention in Sweden had grade 5 students in one school participating as the intervention school and three other schools in the same region as the reference schools (Käll, Nilsson, & Lindén, 2014). The intervention school had twice a week physical activities in addition to the two weekly hours of curricular physical activity, while the three reference schools only had the two weekly hours of curricular physical activity. The results indicated that there were higher proportions of students in the intervention school that achieved the national goals in all three subjects (Swedish, mathematics and English) compared to the three-reference school. Therefore, the school-based intervention significantly improved the student's academic achievement. The authors concluded that the extended physical activity completed in the school might have

improved student's concentration, which may have positively contributed to their academic achievement.

There is evidence to support school-based intervention programs in elementary schools that integrates physical activity into the day; however, the success of an intervention program may differ based on grade level. In one study, second and third grade classes from six elementary schools were randomly assigned to either an intervention group that participated in physically active academic lessons or a control group that participated in regular classroom lessons (Mullender-Wijnsma, et al., 2015). Third grade students in the intervention group scored significantly higher on mathematics and reading than students in the control group. However, second grade students in the intervention group scored significantly lower on mathematics than the control group, and no differences were found on reading between groups. The authors explained that these differences could partly be due to the difference in moderate-to-vigorous physical activity (MVPA) because the second grade children participated in MVPA significantly more than the third grade children.

A similar study examined the association between objectively measured physical activity and academic achievement in 7th and 9th grade Dutch students (Van Dijk, De Groot, Savelberg, Van Acker, & Kirschner, 2014). The students wore accelerometers for one full week, 24 hours per day. The results for grade 7 indicated that the total physical activity was negatively associated with academic achievement and MVPA was negatively associated with both academic achievement and mathematics performance. However, grade 9 student's total physical activity and MVPA were positively associated with

mathematics performance. The authors found that the association between physical activity and academic performance might be impacted by school grade.

Weekly Hours

The number of hours that one engages in physical activity has been shown to contribute to academic performance. When students meet or exceed the daily guidelines of physical activity, the academic performance benefits increase. Moreover, this finding extends across cultures.

In one study, school performance was associated with the frequency of attending physical education classes. Researchers observed the number of physical education classes attended per week and school performance for 75,066 Korean students (Sang-Yeob, & Wi-Young, 2012). The results indicate that students who attended more than three physical education classes improved school performance. Students who attended less than three physical education classes per week had poor school performance, which can be associated with poor cognitive function and memory function of the brain. This is due to the fact that school performance can be highly related to skills such as reading, speaking, writing, and understanding.

Another study of 1271 students from urban Santiago, Chile examined the relationship between systematic physical activity and academic performance (Burrows, et al., 2014). The study measured scheduled exercise (school-based physical education and sport activities) by having participants fill out questionnaires. The results indicated that students who participated in less than two hours of weekly scheduled physical activity had significantly lower performance in language, mathematics and science. It is

concluded from the authors that students who participated in more than four hours per week of scheduled physical activity were twice more likely to fall into the group with the highest academic performance.

A final study focused on the relationship between weekly hours of physical activity and academic performance by analyzing the number of weekly physical activity hours beyond physical education classes at school (Batista, Cubo, Honorio & Martins, 2016). Five hundred and thirty one students from Portugal participated in a study that aimed to relate physical activity to self-concept, self-esteem and academic performance. The study concluded that the students, who had the highest number of weekly hours of physical activity, had a significantly higher level of academic achievement in mathematics, English and science studies, compared to the students with less hours of physical activity weekly. In contrast, physical activity did not show to be a significant factor in the level of self-concept and self-esteem of students.

Summary

When determining the connection between physical activity and academic performances, factors such as, effects on executive functioning, effects on academic core subjects and weekly hours need to be taken into consideration. Studies have shown that physical activity has a positive effect on academic performance for students in academic core subjects and executive function. Additionally, conclusions have led to the idea that higher number of weekly hours of physical activity for students can achieve higher levels of academic achievement in core academic subjects (Batista, Cubo, Honorio & Martins, 2016). Since, physical activity can increase executive functioning, which is essential for

academic achievement, physical activity has demonstrated to be an important component in academics.

CHAPTER 4

DISCUSSION

This section will discuss in further detail how physical activity can contribute to grade level differences, advocating for physical education, comprehensive school physical activity program, after school sport participation. Limitations and recommendations for future research will be discussed based from the studies in the critical mass.

Grade Level Differences

Although most of the articles concluded that physical activity increased academic performance, two studies found that different grade levels experienced different outcomes from the physical activity intervention. Students in different grade levels are at different developmental stages in their life. The difference between grade levels can determine if an activity or intervention is inappropriate because it is either not challenging enough or too challenging for the students.

For instance, in one study the authors explained that the third grade intervention group scored significantly higher on mathematics and reading than students in the control group, but second grade students in the intervention group scored significantly lower on mathematics (Mullender-Wijnsma, et al., 2015). The authors stated how the differences

could have been partly explained by the difference in MVPA, due to the second grade children participating in MVPA significantly more than third grade children.

Teachers need to be able to adjust to the grade level differences in order to set students up for success. Just because one intervention worked with one grade level, does not mean it will work with another grade level.

Advocating For Physical Education

The American Heart Association has indicated the recent and continuing decline in physical education classes in school in the United States (US). Therefore, students are not receiving as much physical activity throughout their day. Research has concluded that the more physical activity hours a student participates in can improve academic performance. Burrows and colleagues (2014) concluded that students who dedicated more than four hours per week to scheduled physical activity were more likely to fall into the group with the highest academic performance. Similarly, San-Yeob and Wi- Young (2012) found that students who attended more than three physical education classes per week had improved school performance. Schools may be doing a disservice to their students by decreasing the amount of physical education classes, thus decreasing their physical activity.

Physical educators can use these results to advocate for their subject area. Physical education class is focused around the notion of students learning through movement. Since movement achieves physical activity, students engaged in physical education may also increase their academic performance by improving their memory, which helps increase their grades in core subjects. Physical Educators can use scientific evidence to promote their subject area as a significant contributor to overall academics.

Physical educator can further advocate for their subject area by integrating core subjects within physical education class. This can help with transfer of learning, which can further improve student's memory of information because students are learning and performing information in more than one subject area. For instance, physical education teachers can incorporate counting in Spanish or Italian into the warm-up, so students can get the reinforcement of information. Another example could be when the physical education teacher incorporates PE Passwords into the lesson to review vocabulary currently used in English class.

Comprehensive School Physical Activity Program

Although the purpose of Physical Education class is teaching through physical activity, Physical Education should not be the only time in the day that students are physically active (SPARK, 2017). National Association for Sport and Physical Education (NASPE) released a position statement advising that all P-12 schools implement a CSPAP, which not only increases physical activity time, but also positively affects student's academic performance (Hunt & Metzler, 2017). One of the aspects that comprise the framework of a CSPAP is physical activity during school. This approach integrates physical activity within the classroom environment, by using classroom activity breaks and recess. One study that supports this idea had students complete either physical activity integrated math problems or seated math problems (Vazou & Smiley-Oyen, 2014). It was concluded that students who completed the physical activity integrated math problems had improved response time over the students who completed the seated math problems. Another school-based intervention study also concluded that

the intervention group had higher proportions of students that achieved the national goals in three subjects compared to the three reference schools (Käll, Nilsson & Lindén, 2014).

CSPAP programs may also be an effective way to encourage engagement in physical activity. Students are more likely to keep pursuing physical activity if the activity is performed in more than one place; this is called transfer of learning. When students see physical activity done in the classroom, on breaks, before and after school, students will associate physical activity as a way of life, instead of just in Physical Education class. In order for this transfer of learning to be successful, all staff must be willing to encourage physical activity in the classroom and perform physical activity themselves.

After School Sport Participation

After school sports participation is another way for students to be physically active, which can further increase their academic performance. Batista and colleagues (2016) found that students with the highest number of weekly hours of physical activity had a significantly higher level of academic achievement. Since practices and or games can last about two hours, students are increasing potential time to enhance their abilities to be better-equipped learners. However, if a student cannot uphold a certain grade point average, majority of schools will kick the student off the sports team. Even though administration is abiding by their protocol, the school may be doing a disservice to the student. Burrows and colleagues (2014) concluded that students who participated in less than two hours of weekly scheduled physical activity had significantly lower performance in academic subjects. Therefore, schools need to implement an alternative solution to the student who is failing multiple subjects rather than remove them from the

sports team. Coaches and teachers need to work together and implement a plan to keep the student active while improving their academic performance. As educators we should be promoting the best opportunities for students to be successful.

Limitations

Certain limitation arose while looking at the critical mass of articles from this paper. One limitation in the critical mass was the participants in the study might not represent other geographic regions. Burrows and colleagues (2014) expressed that their participants were drawn from one region in Chile; thus, the results may not represent other regions in Chile. Another limitation is that the majority of the studies were conducted outside the United States (US). It cannot be assumed that the same results that occurred in other geographical areas would occur in the US.

Another limitation from the critical mass is that the level of physical activity was not taken into account. Although the results indicate that general physical activity can improve academic performance, there was not a measure of the physical activity level during their physical education lesson (Dalziell, Boyle, & Mutrie, 2015). This made it hard to determine if the level of intensity during physical activity affected their academic performance. Burrows and colleagues (2014) also focused on measured hours of scheduled exercise regardless of the exercise intensity. Although the results indicated that academic performance increased, the results did not specify at what intensity made their performance increase.

The last limitation in the critical mass is the amount of participants in the studies. In one study, only one intervention school was included, which could have made the results less valid (Käll, Nilsson & Lindén, 2014). According to the authors, the results

could have been jeopardized because of this. Another study stated that there were a fairly small number of classes that participated in the study (Mullender-Wijnsma et al., 2015). Ardoy et al. (2013) also states that their main limitation was the small sample size of only 67 total participants within one control group and two intervention groups. Due to a limited number of participants, the results cannot be widely generalized.

Recommendation for Future Research

Based upon the critical mass, a few recommendations for further research appeared in order to validate the results. Studies should have multiple intervention groups and from different geographical areas, in order to widen their results by participants and regions. Previous studies have identified that there can be a positive relationship between physical activity and academic performance, but the level of physical activity that contributes to the increased academic performance has yet to be identified. Future studies need to examine the level of MVPA that increases student's academic performance.

Since two studies indicated that one intervention had mixed results for two different grade levels, future research needs to determine if the intervention was the cause of mixed results. The method of the intervention should be age and developmentally appropriate for the grade levels it is being administered to. Therefore, future studies need to determine if there is a relationship between grade level and physical activity intervention on academic performance.

Conclusions

Considering the limitations, the results from the articles still indicate that there is a positive relationship between physical activity and student's academic performance.

Aside from two studies indicating mixed results, overall, physical activity has improved student's academic performance. These results can further enhance the arguments to integrate physical activity before, during and after school and to treat physical education as an important academic subject. It is imperative for all educators to give students the best opportunity for academic success.

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Appendix A

Synthesis Article Grid

Author	Title	Source	Purpose	Methods & Procedures	Analyses	Findings	Recommendations
*Arday, Fernandez-Rodriguez, Jimenez-Pavon, Castillo, Ruiz, & Ortega	A physical education trail improves adolescents' cognitive performance and academic achievement: The EDUFIT study	Scandinavian Journal of Medicine & Sports	To analyze the effects of an intervention focused on increasing the time and intensity in PE, on adolescents' cognitive performance and academic achievement	4- month trial, three class in control, one class in intervention, control received regular PE, intervention received four PE sessions/ week of high intensity	Cognitive performance (non-verbal and verbal ability, abstract reasoning, spatial ability, verbal reasoning and numerical ability) was assessed	Results indicated that the number and intensity of PE sessions per week has a positive effect on both cognitive performance and academic achievement	Larger sample sizes should confirm or contrast these findings

			ent		by the Spanish Overall and Factorial Intelligence Test, and academic achievement by school grades		
*Batista, Cubo, Honorio, and Martins	The practice of physical activity related to self-esteem and academic performance in students of basic education	Journal of Human Sport & Exercise	The purpose of this study was to determine the influence of physical activity on self-concept, self-esteem and school performance in children of basic education	531 students (295 males and 236 females) ranging from 8 to 10 years old 394 students participated in physical activity and 137 no physical activity	SPSS computer program ANOVA, test of Kruskal-Wallis H test and Mann-Whitney, Wilcoxon, Pearson's R and T for Test Samples Related	Students who participated in physical activity more showed a significantly higher level of academic achievement	
Benzing, Heinks, Eggenberger, and Schmidt	Acute cognitively engaging exergame-based physical activity enhances	PLOS-ONE	The purpose of the study explain the influence of cognitive	65 males from 13 through 16 years old were randomly assigned to one of three	Executive functions were assessed before and after each	The physical activity condition with a high level of cognitive	Age and additional related aspects (developmental status of the subjects)

	executive functions in adolescents		engagement comprised in an acute bout of exergame-based physical activity on executive functions (inhibition, cognitive flexibility) in adolescents	groups: physical activity with high levels of cognitive engagement during active video gaming, physical activity with low levels of cognitive engagement during active video gaming and sedentary with low levels of cognitive engaging during passive video watching.	condition using D-KEFS design fluency test	engagement resulted significantly better performance in cognitive flexibility compared to conditions with low levels of cognitive engagement. Acute physical activity with high cognitive engagement could be more efficient than physical activity of the same intensity with low cognitive engagement	
*Burrows,	Schedule	Journal of	The purpose	Random sample	SIMCE test	80% of students	

Correa-Burrows, Orellana, Almagia, Lizana, and Ivanovic	physical activity is associated with better academic performance in Chilean school-age children	Physical Activity and Health, Human Kinetics	of this study was to examine the relationship between systematic physical activity and academic performance in school kids	of 1271 students from urban Santiago in 5 th and 9 th grade. Students took the 2009 System for the Assessment of Educational Quality (SIMCE) tests, measuring physical activity habits, anthropometric characteristics, and socioeconomic status	(academic performance)	reported less than two hours of weekly scheduled exercise. Students allocating more than 4 hours to weekly scheduled exercise were 2.1 times more likely to fall into the group with the highest academic performance. Students 11 to 18 years old observed a positive association between physical activity involvement and academic achievement	
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						ment	
*Dalziel, Boyle, and Mutri	Better movers and thinkers (BMT): An exploratory study of an innovative approach to physical education	Europe's Journal of Psychology	The purpose of this study was to determine if BMT positively influences academic skills and to determine the students and staff's perceptions of this approach	46 children ranging from 9 to 10 years old who attended two Primary 6 class in Scotland, UK One school was the intervention school (25 students), one school was control school (21 students) Both schools provided two 60-minute sessions of PE each week, for 1 weeks Control group-standard PE provision Intervention-received BMT	ANCOVA using SPSS	Significant improved overall score changes in memory, phonological awareness and segmentation abilities for participants in the BMT intervention conditions The improvements in memory hold specific significance to learning and educational processes because memory is considered the most basic and	Future studies need to take into account the link between physical activity and academic achievement to help account for the differences identified within this pilot study

				provision		fundamental concepts required for learning	
Hunt and Metzler	Adaption of comprehensive school physical activity programs: A literature review	The Physical Educator	The purpose of the review determine the framework of CSPAP (the adoption and implementation in schools)	Refereed journal articles, electronic reports, position statements, and book published between 1991 and 2015		Expands the knowledge base, which is necessary to transform CSPAP theory into adoptable and maintainable model for schools	Customized approaches to CSPAP implementation, extensive needs assessments, and to examine each school thoroughly
*Kall, Nilsson, and Linden,	The impact of a physical activity intervention program on academic achievement in a Swedish elementary school setting	Journal of School Health	The purpose of the study was to figure out the impact of a physical activity intervention program on academic performance	5 th grade students Intervention group and control group (Intervention group) Physical activity led by local sports club instructors, twice a week "play and motion"	Statistical Package for Social Sciences	A school-based physical activity intervention program, which make students more physically active during the school day, significantly improved the	Future high-quality research in this field and into the explanatory mechanisms and the dosage relationship between physical activity and academic achievement is needed

				activities completed in addition to the 2 hours of curricular physical activity, lasted 30-45 minutes		children's academic achievement	
*Kim & Wi-Young So	The relationship between school performance and the number of physical education classes attended by Korean adolescent students	Journal of Sports Science and Medicine	The purpose of the study is to examine whether the number of PE classes attended per week is related to school performance in Korean adolescent students	75,066 adolescent students (39,612 boys and 35,454 girls) from middle school and high school of 800 middle and high schools	Multivariate logistic regression analysis (determining the relationship between school performance and the number of PE classes attended per week)	Attending more than 3 PE classes per week was positively correlated with improved school performance, so attending less than 3 PE classes per week was negatively correlated with school performance in Korean adolescent students	Better-designed studies should be performed to determine the extent to which these variables, including the covariate variables, affect the school performance of Korean adolescents
Maher, Lewis,	The associati	Journal of	The purpose	285 Australia		Higher academi	Examine relationships

Katzmarzyk, Dumuid, Cassidy, & Olds	ons between physical activity, sedentary behavior and academic performance	Science and Medicine in Sport Science Direct	of this study was to determine the connections among children's moderate-to-vigorous physical activity (MVPA), sedentary behaviors and academic performance	n children from 9-11 years old from randomly selected schools that undertook 7-day 24-hour accelerometry to objectively determine their MVPA and sedentary behavior.	c performance was strongly and consistently related to higher sedentary time, with significant relationships seen across all five academic domains. Sedentary behavior can have a positive relationship with non-physical outcomes. Positive relationships between MVPA and literacy and numeracy imply that it holds an	between sedentary time and a wide range of social and academic outcomes
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						important place in children's lives	
Marques, Gomez, Martins, Catunda, and Sarmento,	Association between physical education, school-based physical activity, and academic performance: A systematic review	Retos	The purpose of this report is to perform a systematic review of the evidence of the relationships between physical education and school-based physical activity, and academic performance.	Three databases from 2000 through 2016 using specific search terms	Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines	Support evidence of a positive relationship of physical education or school-based physical activity with academic performance	
*Mullender-Wunsmann, Hartmann, Greeff, Bosker, Doolaar, Visscher	Improving academic performance of school-age children by physical activity in the classroom: 1-Year program	Journal of school health	The purpose of this article was to describe the program implementation and effects on academic achievement after	6 elementary schools-second and third grade classes participated Intervention group participated in physically	Mann-Whitney U test analyzed the time on task differences between second and third grade classes related to	Third graders in the intervention group scored significantly higher on both mathematics and reading Second graders	The effects of the improved intervention will be investigated

	evaluation		1 year	active academic lessons Control group in regular classroom lesson Children were pretested and post tested on mathematics and reading	lesson content (paying attention or not) and related to movements (exercising or not) Analysis of covariances (ANOVAs) analyzed (F & V) intervention on academic achievement on the posttest mathematics and reading scores	in the intervention group scored significantly lower on mathematics, no differences were found on reading	
*Van der Niet & Smith	Effects of a cognitively demanding aerobic intervention during recess on children's	Pediatric Exercise Science Human Kinetics	The purpose of this study was to analyze the effects of a physical activity program, aerobic exercise	Children ranging from 8-12 years old were recruited from three primary schools Control group-32 boys,	Data analyses were performed using SPSS 20.0 for Windows Analyses of variance	Intervention group displayed significantly greater improvement on inhibition and verbal	Determine children's optimal challenge point in terms of intensity and cognitive engagement of physical activity

	physical fitness and executive functioning		and cognitively engaging physical activities, on children's physical fitness and executive functions	20 girls Intervention group- 19 boys and 34 girls) Intervention group participated in a 22-week physical activity program for 30 min during lunch recess, twice a week. Control group followed their normal lunch routine	(ANOVA) were performed on baseline and posttest data	working memory skills. Physical activity program including aerobic exercise and cognitively engaging physical activities can enhance aspects of executive functioning in primary school children	
*Van Dijk, De Groot, Savelberg, Acker and Kirschner	The association between objectively measured physical activity and academic achievement in Dutch adolescents:	Journal of Sport & Exercise Psychology	The purpose of this study was to discover the relationship among physical activity and academic achievement in adolescents	255 students in 7 th and 9 th grade Participants wore accelerometers on right thigh for one week, 24 hours a day. Participants kept diary	ActivPAL 3 accelerometer to measure habitual physical activity levels during a normal school week Data was downloaded and	Overall, no significant relationship between physical activity and academic performance 7 th grade's physical	Look into the differences in physical activity levels between weekdays and weekend days and take executive functioning and time dedicated to homework

	Findings from the goals study			during full week to report vigorous intensity physical activities.	processed with ActivPAL Professional software	activity volume (Total PA) negatively associated with academic achievement, while moderate to vigorous physical activity (MVPA) negatively associated both academic achievement with mathematics performance 9 th graders both Total PA and MVPA were positively associated with mathematics performance	into account
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						Total PA was positively associated with executive functioning. In conclusion, the relationship among physical activity and academic achievement in adolescents is complex and might be affected by academic year, physical activity volume and intensity and school grade.	
*Vazou & Smiley-Oyen	Moving and academic learning are not antagonists:	Journal of Sport & Exercise Psychology	The purpose of this study was to discover the acute	35 children ranging from 9 to 11 years old in 3 rd to 5 th	IBM SPSS Statistics 19 ANOVA	Following the integrated physical activity, the	

	Acute effects on executive function and enjoyment		effect of a 10-min bout of aerobic physical activity integrated with math practice, compared with a seated math practice, on executive function and enjoyment among normal weight and overweight children	grade from 12 elementary schools		response time in the Standard Flanker improved more than after seated practice. Integrating physical activity with academic instruction may be a realist strategy for promoting physical activity because it may facilitate, not antagonize, executive function	
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