



Improved learning through physical activity

Physical activity enhances children's learning capabilities and leads to better performance in the classroom.



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Introduction

Academic success is an outcome most parents and schools prioritise and strive to attain for their children. Recent evidence suggests increasing the time children spend in sport or physical activity is a potential strategy for optimising children's learning. The following discussion summarises Australian and international research surrounding the relationship between physical activity and academic success. This review of the literature supports the theory that children who are more physically active are more likely to achieve better academically. As an explanation for this relationship, the mechanism of improved cognitive function (information processing in the brain) with increasing physical activity levels is presented. A physiological explanation for ways in which increased physical activity may enhance cognitive function is also presented.

Academic achievement and physical activity

Evidence of the relationship between physical activity and academic achievement and/or cognitive functioning is detailed in Tables 1 and 2. While a few studies have failed to find a relationship^{1, 2}, the great majority of University based, internationally published research in this field have found a positive association between children's level of physical activity or sport and cognitive functioning or academic success at the time of the study or at follow up. In summary, these studies and reviews found that:

- Physical activity was a significant, positive predictor of academic achievement. Body mass index (BMI), diet and physical activity explained up to 24% of the variance in academic achievement after controlling for gender, parental education, family structure and absenteeism³;
- There was a significant, positive link between academic performance and physical activity participation⁴;
- Study groups who received extra physical education (PE) from a trained specialist or specially trained generalist teacher, had advantage over control groups in teacher ratings of classroom behaviour⁵;

- A significant, positive difference in academic achievement was detected between a study group, who received extra PE and a control group, who did not receive extra PE in a second year follow up⁶;
- Higher school ratings of scholastic ability were associated with higher physical fitness, physical capacity and physical activity⁷;
- Students reporting a high level of exercise spent more time in sport and achieved higher grade point averages⁸;
- There was a significant, positive correlation between academic ability and sport performance⁹;
- The frequency and extent of sports participation was significantly higher for students with high self-ratings of academic performance¹⁰; and
- Positive achievement orientation was associated with higher physical activity levels¹¹.

In addition to these findings, three studies highlighted that children can spend less time in academic learning sessions and more time being physically active, without affecting academic success or progress^{5, 12, 13}. This suggests increased learning, per unit of time, when children are engaged in higher levels of physical activity¹⁴, supporting the theory that increasing physical activity has a positive effect on learning¹⁵.

One limitation of cross-sectional studies is that they do not exclude the alternate explanation for relationship; such as that children who perform well academically are more likely to be involved in sport and increased physical activity levels. However, results from intervention studies^{6, 13} provide evidence that gains in academic achievement are achieved with increased physical activity, thus suggesting that physical activity is impacting upon learning. In addition, mechanisms underlying the possible relationship pathways (see Figure 1) have been supported by international peer-reviewed studies^{16, 17}.

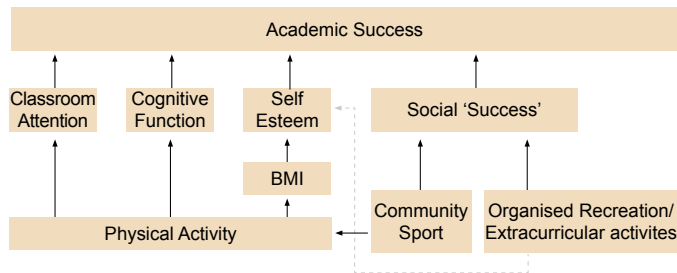


Figure 1: Possible relationship pathways linking involvement in community sport, physical activity and academic success.

Mechanisms by which exercise may improve brain functioning

Physical activity may enhance cognitive functioning, therefore explaining the relationship between physical activity and academic success. Reviews of literature relating to the effects of physical activity on cognitive functioning concluded that:

- There may be some short term benefits of physical activity on concentration¹⁸;
- There is a significant positive relationship between physical activity and cognitive functioning¹⁶; and
- Acute bouts of physical activity exert short term benefits on cognitive functioning of youths¹⁷.

The physiological affects of physical activity on the body help to explain this relationship. Exercise can increase levels of a brain growth factor (brain-derived neurotrophic factor)¹⁹ and has been shown to stimulate learning²⁰. In addition, exercise has been shown to stimulate other brain growth factors, stimulate nerve growth and development and increase resistance to brain injury¹⁹. Regular physical activity may reduce plasma noradrenaline (a vasoconstrictor)²¹ and bouts of exercise have been shown to increase blood flow to the cortex of the brain²². These physiological mechanisms are important explanatory factors, highlighting the need to ensure children are sufficiently active to optimise cognitive functioning.

Association between participation in organised, community sport and recreation and academic achievement

One way in which physical activity levels can be increased is to increase children's involvement in organised community sport¹¹. Organised, community sport and recreational activities have been indicated as exerting a positive effect on academic success and attitude to school^{23, 24}.

Organised recreation may also have a positive effect on children's attitude and self esteem. Total organised, extracurricular activity participation was examined in a cohort of high school students²⁴. The results of this study showed that total extracurricular participation was positively associated with academic self concept, educational aspirations, coursework selection, homework completion, absenteeism, academic achievement and college attendance. One study found that participants doing extracurricular activity alone, or in combination with sports, had higher odds of doing more exercise, liking school and doing more homework²³. These results suggest that identification with school and school values is enhanced by involvement in organised, community sport or recreation.

With evidence that children involved in more organised, community sports or recreation are more likely to perform better academically, there needs to be greater impetus for encouraging and supporting children's involvement in community sports and recreation.

Implications

In Australia, 38% of children aged between 5 and 14 years of age do not participate in any sport organised by a school, club or association²⁵. When broken down by gender this equates to nearly half (46%) of girls and nearly a third (31%) of boys not involved in organised sport. Of boys, 97% participate in two or more hours of physical activity per day when aged five to six; this drops to only 63% when aged between 10 and 12²⁶. The decrease in the proportion of girls engaged in two or more hours of physical activity per day is even more alarming, dropping from 96% to just 41%²⁶ during these same years of development.

The health benefits of regular physical activity are widely known and the increased problems associated with inactivity a huge problem in Australia. Expensive, large trials aimed at increasing activity levels of children have achieved no or only mediocre results. New approaches to encourage parents, carers and schools to optimise children's physical activity levels need to be implemented. Raising awareness of the potential positive relationship between sport, physical activity and academic achievement may provide the necessary motivation for parents, schools and stakeholders to invest in increasing children's physical activity levels.

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Table 1: Intervention and Cross-Sectional Research; Relationship Between Sport/Physical Activity Levels and Academic Success

Author, Year & Organisation	Study design	Sample	Methods	Measures	Results	Ass	Study limitations
Sallis and McKenzie 1999, San Diego State University	Intervention study with two experimental and one control group	Southern California Single school district, 7 schools selected.	Schools were randomly assigned to PE taught either by Specialists, Trained Teacher or Control (class teacher).	<ul style="list-style-type: none"> Achievement test Demographic data Direct observation of time spent in PE classes 	Children in Specialist and Trained Teacher schools spent significantly less time in non-PE curricular and significantly more time doing PE than control schools without impacting on standardised academic achievement test scores.	+ (improved learning per unit of time)	Sample was obtained from affluent school district. Measure of PE class time only (no measure of outside of school sport involvement or time spent being physically active).
Shephard and Lavalley 1994, University of Toronto	Intervention study	546 primary school children from an urban and rural school.	Study group received one additional hour per day of PE, taught by a specialist PE teacher. Controls received 13-14% more academic instruction than the experimental group.	<ul style="list-style-type: none"> Unweighted average of classroom marks for: French (first language) maths, English, science and mean of all five assessments. 	No significant difference in academic achievement detected in first year of study. However the next year grades 2, 3, 5 and 6 study group students significantly outperformed control group students in academic achievement. Girls gained a larger academic advantage than boys in the enhanced physical education class.	+	No information regarding the two year post intervention period prior to follow up. Intervention held at same school, contamination of study and/or control groups may have occurred.

Author, Year & Organisation	Study design	Sample	Methods	Measures	Results	Ass	Study limitations
Dwyer, Coonan et al 1979, 27, University of Tasmania	Intervention study with two experimental and one control group.	519 grade 5 (10 year olds) from seven self selected schools in Adelaide. Three classes were selected from each school.	The three classes randomly allocated to one of three groups: fitness, skill or control. Intervention took place over 14 weeks. Trained and blinded personnel performing physical measurements and marking tests.	<ul style="list-style-type: none"> • Height and weight • Skin-fold thickness • Endurance fitness • Two measures of academic success (an arithmetic and a reading test) 	Despite a substantial reduction in curricular time for the fitness and skills groups (210 mins per week i.e. approximately 14% of total teaching time) there were no significant differences in gains of arithmetic performance or reading skills over the study time period. Two year follow up suggested that the intervention schools had developed an advantage in arithmetic and reading scores with a continuing advantage in teacher ratings of classroom behaviour.	0, +	Study held 27 years ago. Short period of observation.
Dollman and Boshhoff et al 2006, 12, University of South Australia	Cross-sectional study	117 South Australian Primary Schools	Principal (or representative) completed questionnaire. Data regarding academic attainment obtained from the central education department database. School averages for numeracy and literacy were calculated.	<ul style="list-style-type: none"> • Minutes each class spent in PE during previous week 	Schools with high levels of time spent in PE do not have lower academic achievement despite spending less time in academic subjects. No difference in academic scores in relation to time spent in PE.	+ (improved learning per unit of time)	Low response rate of schools invited to participate in study (30%). Schools committed to PE may be more likely to participate. Did not account for quality of PE. School level data used.

Author, Year & Organisation	Study design	Sample	Methods	Measures	Results	Ass	Study limitations
Sigfusdottir, Kristjanson et al20063, Reykjavik University, Olfanleiti	Cross-sectional study	All secondary schools in Iceland sent questionnaires for children aged 14 and 15 (9th and 10th grade). 6346 students in total (82% rr).	Data obtained from 2000 Icelandic study, Youth in Iceland. Self-completed survey instrument.	<ul style="list-style-type: none"> Self report of academic achievement, height, weight and physical activity levels. 	Physical activity is a weak but significant predictor of academic achievement when controlling for other variables. Body mass index, diet and physical activity explained up to 24% of the variance in academic achievement when controlling for gender, parental education, family structure and absenteeism.	+	Height and weight self report. Self report of physical activity levels. Data of individuals who did not enter a height or weight were not included possibly biasing results. Self report of average grades may not have reflected actual grades.
Harrison and Narayan200323, Minneapolis Dept of Health and Family Support	Cross-sectional study	50168 ninth grade public school students from 314 schools.	Self-completed questionnaires in the classroom as part of the Minnesota Student Survey project.	<ul style="list-style-type: none"> Participation level in school sports and extracurricular activities (out-of-school club, or community service) Frequency of physical exertion Orientation to school 	Participants doing sports alone, or in combination with extracurricular activity, had higher odds of doing more exercise. Participants doing extracurricular alone, or in combination with sports, had higher odds of doing more exercise liking school and doing school homework.	n/a	Reliability and validity testing of sports questionnaire not reported. No measure of socioeconomic status. List of extracurricular activities not exhaustive so participants may have been involved in other activity not listed.
Lidner20024, The University of Hong Kong	Cross-sectional study	Two randomly selected classes from randomly selected high schools in Hong Kong. 1447 students in aged 13-17 year.	Self-completed survey instrument	<ul style="list-style-type: none"> Academic records collected from schools Participation questionnaire 	Positive link between academic performance and activity participation. Positive relationship between physical activity participation and by band level of students (school grouping based on primary academic achievement)	+	No objective measure of physical activity used.

Author, Year & Organisation	Study design	Sample	Methods	Measures	Results	Ass	Study limitations
Dwyer, Sallis et al 20017, University of Tasmania	Cross-sectional study	Randomly selected, nationally representative sample of 7961 Australian Schoolchildren aged 7-15 yr.	Data collected by 10 data collectors in each Australian state as part of the Australian Schools Health and Fitness Survey in 1985. Ratings of scholastic ability given for each participant by school representative.	<ul style="list-style-type: none"> Field tests of physical activity and fitness measures collected by trained data collected School ratings of scholastic ability Questionnaire: self perceived academic ability, involvement in exercise and sport 	School ratings of scholastic ability were associated with physical fitness, capacity and activity. There were also weak but consistent associations between scholastic ability and field tests of muscular force, endurance and power. Non-consistent results of cardiorespiratory endurance.	+	Disparity between two cardiorespiratory endurance results may be due to possible measurement bias or confounding. Field tests may have been influenced by motivation of students to perform.
Field, Diego et al 20018, Touch Research Institute, University of Miami School of Medicine	Cross-sectional study	89 high school seniors.	Self-completed questionnaire which included behavioural and exercise measures.	<ul style="list-style-type: none"> Exercise regularity per week Sports involvement Grade point average 	Students reporting a high level of exercise spent more time in sport and higher grade point averages.	+	All measures were self report. Very small number of study participants.
Dexter 19999, University of Cambridge	Cross-sectional study	517 candidates from sample of 17 schools taking the General Certificate of Secondary Education (GCSE).	Review of records and scripts for a sample of candidates for the 1995 GCSE examination.	<ul style="list-style-type: none"> Academic ability calculated from Maths and English GCSE scores GCSE PE score Sport performance measured using GCSE standard assessment 	Significant positive correlation between academic ability and sport performance.	+	Sport performance measurement taken under test conditions may not reflect normal performance.

Author, Year & Organisation	Study design	Sample	Methods	Measures	Results	Ass	Study limitations
Lidner 199910, The University of Hong Kong	Cross-sectional study	One or two randomly selected classes from randomly selected primary and high schools in Hong Kong. 4690 children grades 5-12.	Age adapted self-completed survey instrument.	<ul style="list-style-type: none"> • Sport participation survey instrument • Desired sport activities • Self perceived rating of academic performance • Self perceived rating of sport and physical activity ability 	Frequency and extent of sports participation significantly higher for student with high self-ratings of academic performance.	+	Self reported rating of academic performance used. Use of grouping students of primary school students based on academic scores to their secondary school may have affected their self-perceived academic success.
Sillijer and Quirk 199728, St Bonaventure University (New York)	Cross-sectional study	123 high school students from five schools, selected due to their similarity.	Counsellor identified students involved in soccer. Data collected on a data sheet by school counsellor in-season and out-of-season..	<ul style="list-style-type: none"> • Grade point averages (GPA) for in and out of season. • School absences 	Participants had significantly higher GPA in-season than out-of-season.	+	Data collected only for soccer players. Small sample size. Schools not randomly selected. GPA may have been influenced by another seasonal factor.
Dwyer, Blizzard et al 199615, The University of Tasmania	Cross-sectional study	2400 Australian students randomly selected from 9000 school children recruited into the ASHRS study from 109 schools.	Self administered questionnaire and field testing by trained personnel.	<ul style="list-style-type: none"> • Skinfold thickness • Endurance fitness • Leisure activity • Academic performance 	Physical activity and physical capacity were positively related to scholastic rating. These associations remained after adjusting for relevant confounders.	+	

Author, Year & Organisation	Study design	Sample	Methods	Measures	Results	Ass	Study limitations
Fisher, Juszczak et al 19961, North Shore University Hospital and Cornwell University Medical College	Cross-sectional study	838 students in one school.	Self-completed questionnaires during gym class.	<ul style="list-style-type: none"> Sports questionnaire including number and type of sports and time spent in sport Self report average grade 	Time spent playing sport was not significantly associated with academic performance.	0	All students were involved in at least one sport. Small sample. All measures self-report. Questionnaires distributed during gym class. Reliability and validity testing of sports questionnaire not reported.
Pate, Heath et. Al 199629, University of South Carolina	Cross-sectional study	11631 high school students.	Self-completed questionnaire.	<ul style="list-style-type: none"> Self perceived academic performance Level of exercise in last 2 weeks Involvement in sports teams (community and school based) 	High physical activity levels were associated with participation in high levels of sport. Low activity was associated with low perception of academic performance.	+	Measures were all self report. Perception of academic performance may not reflect actual academic performance.

Table 2: Research Reviews; Relationship Between Participation in Sport/Physical Activity Levels and Academic Success

Author, Year & Organisation	Studies included	Methods/Presentation of literature	Results	Ass	Review limitations
Taras 2005 ¹⁸ , University of California	14 articles examining the association between physical activity in school aged children and academic performance identified	Description of previous studies presented in table form and discussed.	May be some short term benefits of physical activity on concentration.	+	Review did not identify all studies in the relevant area.
Sibley and Etnier 2003 ¹⁶ , Arizona State University	16 studies using true experimental design were included in the analysis, 7 of these were unpublished.	Studies were coded by design, subject characteristics, activity characteristics and cognitive assessment	Significant positive relationship between physical activity and cognitive functioning in children. Effect size 0.32 which indicates that the group exposed to physical activity showed an improvement in cognition equivalent to 0.5 of a standard deviation. Results support possibility that participation in physical activity causes improvements in cognitive function.	+	Results of meta-analysis are limited by the designs of the studies in the area. 7 studies were unpublished so may have not met publication review rigour. Some studies were 35 years old
Tomporowski 2003 ¹⁷ , University of Georgia	Review of four research studies on youth without clinical disorder and 18 with clinical disorders	Description of findings of studies performed to assess acute effects of exercise on children's and adolescents' behaviour and cognition	Acute bouts of physical activity exert short-term positive benefits on the behavioural and cognitive functioning of youths.	+	Review based on mainly studies on youths with clinical disorders and focuses on acute bouts of activity.
Sallis, Procha et al 2000 ¹¹ , San Diego State University	From 102 published papers identified 54 of studies of children were reviewed.	Detailed tables were created for the studies and coded for quality of physical activity measure used, results and analysis. Percentages and tallies were used to the number of associations supporting expected associations.	Being on a school sports team and having a positive achievement orientation were positively associated with physical activity levels.	N/A	Diversity of variables, measures, subject samples and analysis strategies prevented true meta-analysis (whereby raw data is combined and analysed). Bias against publication of negative findings may have affected results. Only English language published papers included in the review.
Shephard 1997 ³⁰ , University of Toronto	Review of four intervention projects	Description of previous intervention studies: methods, results, conclusions and limitations.	Academic learning per unit of class time is enhanced in physically active children.	+ (improved learning per unit of time)	Review limited to only interpretation of findings from four studies.

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