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Sport, physical activity and educational achievement – towards an explanatory model

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ABSTRACT

Sport and other forms of physical activities have traditionally held an ambiguous place within schooling, often being pushed to the margins. At the same time, there is a consensus that such activities are necessary for the healthy development of young people. This was proven during the second half of the last century, representing a revolution in the understanding of health. Recent developments in neurology, psychology and related sciences hint at a second revolution in which a strict distinction between mind and body has become redundant. This article examines the case that sport and physical activity can make distinctive contributions to educational achievement, and a host of wider benefits. Focusing on cognitive functioning, psychosocial development, school engagement and general educational attainment, the article reviews the available evidence and concludes that there is sufficient reason to believe that sports and physical activity can make useful contributions to educational achievement.

Introduction – *Mens sana in corpore sano?*

The Roman poet Juvenal ([undated](#)), writing around the first century AD, popularized the view that there was a close relationship between physical health and mental power, with the maxim, *Mens sana in corpore sano* ('a sound mind in a healthy body'). In fact, Juvenal was paraphrasing an earlier saying attributed to the ancient Greek philosopher Thales, who offered a simple prescription for the good life that still seems plausible today: 'Who is happy? The person who has a healthy body, a resourceful mind and a docile nature' (Laertius 1925). Juvenal's words were an early signal of a tradition of linking the development and functioning of the mind and of body that continues to the present day. For most of this time, this tradition competed unsuccessfully with another, present in the writing of Plato, and strands of the Christian religion, but most associated with the French philosopher René Descartes. This 'Cartesian' view portrayed the body not as an inseparable partner of the mind, but as its rather brutish vessel. It is not difficult to see the influences of this tradition on most models of schooling and their disembodied conceptions of human beings, in which the mind is both the subject and object of education, and the body is a service and transport role that is separate and inferior (Overton 2008).

It is only quite recently that science has caught up with the insights of the ancient Greeks to the extent that it can now speak with any confidence about the relationships between the body and the mind, and between physical activity and mental functioning. The evidence is beginning to suggest that Juvenile and Thales may have been on to something. Recent developments in educational research, psychology and brain science have led to a new level of understanding of the relationships between physical activity and educational achievement. New evidence has brought about a revolution in the understanding of how young people learn and develop.

Schools are complex places and exert their influence in many ways. The first part of this article reviews the historical context in which physical activities find themselves in discussions of their place in education. As the introduction makes clear, there is a strongly held cultural bias that presumes that matters of the body are adjunct to education, rather than part of it, and this continues to delineate and limit the use of physical activity in the curriculum. The article goes on to examine a number of factors that seem to be particularly important to the issue of the nexus of physical activity and educational achievement:

- cognitive functioning;
- psychosocial development;
- school engagement;
- educational attainment.

So, this article discusses the potential contributions sport and other forms of physical activity can make to educational achievement. The relevance of some of these mechanisms to achievement in school might seem self-evident. Cognition has a powerful effect on learning, as do psychosocial factors, like emotional security and the development of friendships. The importance of school engagement, which is primarily about relationships between young people and adults, has been less discussed by researchers. However, there is evidence to suggest that young people's perceptions of school as a place that is friendly and caring are key influences on academic achievement (Lawson and Lawson 2013). Most studies that have explored possible associations between activity and schooling have focused on examination results and formal assessment scores, and the appeal of these relative simple measures for researchers is obvious. Improving performance in standardized tests is important, of course. Examination results and school grades increase access to further educational and vocational opportunities. But it does not follow from this acknowledgement that they are the only, or even the primary, goals of schooling. There is certainly a practical imperative for supporting child to succeed in terms of test scores and examinations, but this should not be at the expense of wider and less easily measured outcomes. As this article makes clear, sport and other physical activities can contribute to both the narrow aim of examination success and the less-easily defined psychological and social outcomes that help children live lives of flourishing.

Physical activity and the brain

Serious scientific investigations of the relationship of the brain and physical activity date back to the early 1980s, when scientists discovered that activity increased secretion of endorphins (hormones secreted within the brain and nervous system). This effect has since been linked to a variety of psychological changes, such as: positive mood state changes and

euphoria; physical changes to the brain, such as increased cerebral blood flow; growth of nerve cells in the brain's centre of learning and memory, increased density of networks of nerve cells and increased brain tissue volume (Harber and Sutton 1984). These changes make a compelling list since they affect learning directly. One group of changes represent what could be called the psychology or 'mindset' of learning; another reflects the neurophysiology or 'mechanism' of learning. It is necessary to examine the effects of physical activity on both the mindset and the mechanism of learning to understand the ways in which it might impact on educational achievement. Figure 1 offers a simplified heuristic of this relationship.

Numerous tests and measures have been developed since those early days. Some of these infer cognitive processes from the observation of behaviour (e.g. the ability to complete cognitive tests), but rapid advances in understanding truly began when reliable and accessible methods were developed that allowed direct measures of brain activity. The development of these technologies has offered a new perspective on the subject of physical activity and the brain (Boecker et al. 2012).

Physical activity and cognitive function

Most studies in the area of physical activity and cognitive functioning have been with older adults, but there is growing evidence from research with young people to support these findings, too (Hillman, Erickson, and Kramer 2008). Physical activity play during early childhood is known to have profound effects on youth people's overall development, supporting health muscular-skeletal growth, perceptual and motor skill development and the ability to calibrate emotional reactions to an unpredictable world (Doherty and Bailey 2003). Movement affects all aspects of the young child's life, including the developing brain, and activity influences the electrical activity occurring in the cerebral cortex, which is the area of the brain most responsible for cognition (Lardon and Polich 1996). Studies report increasing levels of physical activity and aerobic fitness lead to faster reaction time, improved attention and faster cognitive processing (Hillman et al. 2009). Learning and practicing movement skills, such as those used in sports, add an extra dimension to this contribution.

While scientists are still trying to understand the precise mechanisms underlying these changes, the pattern of findings suggests that changes are most marked during childhood (Hillman, Castelli, and Buck 2005). This supports the contention that the first 10 or so years represent a crucial period in development, and consequently that the preschool and primary phases of schooling are not just the first, but are also the most important in terms of predicting later educational and career success (Bailey et al. 2010).

Research has shown that regular physical activity leads to improvements in a range of cognitive functions, including information processing, attention and executive function (Chaddock et al. 2011). Positive relations have been reported between physical activity



Figure 1. The relationships between mindset and mechanisms of learning and educational achievement.

and cognitive performance in school-age children in a range of measurement categories, including perceptual skills, IQ, verbal and mathematic tests. Studies have found a positive relationship between increased physical activity and concentration and sleep, and both of these factors can affect the ability to engage with school (Short et al. 2013). A US study tested the hypothesis that regular physical activity has its greatest effect in terms of executive function (processes used to perform activities such as planning, organizing, paying attention to and remembering details and managing time and space). Inactive and overweight primary school-aged children undertook a controlled experiment involving 13-week after-school programme. Cognitive tests of different aspects of executive function carried out before and after the experiment showed that physical activity was associated with improved performance in each task, with the most positive results being found among those who exercised the longest each day. Significant improvements in mathematics test scores were also observed (Davis et al. 2011).

Even relatively brief bursts of physical activity seem to be able to contribute to improved cognitive functioning. In fact, there seems to be residual effects of short bursts of activity: benefits continue to contribute to executive functioning after the activity has finished. A two-year study of primary school students found that 10–15 min of classroom-based physical activity that were matched to core academic subjects such as spelling and mathematics saw they were more likely to have higher scores than those who did not experience the intervention (Hollar et al. 2010). An earlier study found that aerobic exercise for 5–10 min improved arithmetic performance (Molloy 1989). The beneficial effects of a burst of moderate intensity exercise for as little as five minutes have been found to increase brain processes, improve focus and enhances cognitive control for up to one hour later (Pontifex et al. 2013), leading one set of researchers to the conclusion that physical activity should be scheduled ‘before important subjects like mathematics and not at the end of the school day’ (Kubesch et al. 2009). Cognitive function may also benefit from increased energy generation, as well as breaks from sedentary (such as classroom-based) work. Whilst most studies have tested the effects of short-term interventions, effects may be more sustainable when physical activity is maintained over a period of time. An important set of studies in this regard relates to the Executive Function Hypothesis, with findings suggesting that aerobic exercise results in improved general intellectual performance, and that the most profound effects are seen when tests were focused on executive function (Tomprowski et al. 2008). Findings like these support the case for so-called ‘Active Classrooms’, which are standard classrooms incorporating physical activity breaks or movement activities throughout the day.

The relationships between physical activity and the brain are complex, and there is a great deal more to learn. Although it is known that exercise modifies the biological structures and systems of the brain. It is less well understood how exactly this happens and how these changes affect human behaviour. In addition, the scale of the effects of physical activity on the brain are probably not as great as is sometimes represented in the popular media, and caution needs to be shown when basing decisions and ambitions on interpretations of scientific research. Nevertheless, cautious optimism seems to be justified.

Fitness and cognitive functioning

Physical fitness, especially cardiorespiratory fitness can affect the brain in numerous ways. As with measures of physical activity, some of the most persuasive evidence related to

fitness comes from older people, and research with young people is much less advanced. The evidence base of the relationship between exercise and cognitive functioning in younger adults is mixed, with some studies reporting associations between cardiovascular fitness and cognitive performance in young adults (Hillman, Castelli, and Buck 2005), and others suggest no relationship (Etnier et al. 2006). Generally speaking, it seems likely that fitness does help cognitive functioning. For example, a seminal study reported a relationship between participation in an intensive physical education programme (that included activity breaks during classroom lessons) and educational achievement in a primary school (Ismail 1967). Standardized tests showed that children taking part in the 8-month programme improved their performance in a range of academic tests compared to those in traditional physical education classes. Studies of recess/break times have corroborated these results (Donnelly and Lambourne 2011).

An important study from Sweden examined physical fitness, intelligence scores, school achievement and sibling data from every man born between 1950 and 1976 who enlisted for military service at age 18 (Åberg et al. 2009). Analysis revealed a positive association between cardiovascular fitness and cognitive performance at 18 years of age. In addition, changes in physical fitness measures between 15 and 18 years predicted cognitive performance at 18 years, and cardiovascular fitness during early adulthood predicted socio-economic status and educational attainment later in life. The authors of this study interpreted these findings in terms of support for the development of 'brain plasticity' (the ability to adapt to external conditions and challenges), and the 'cardiovascular fitness hypothesis' (the hypothesis that cardiovascular (i.e. aerobic) fitness is the physiological mediator that explains the relationship between exercise and improved cognitive performance) as a result of exercise in early adulthood. These findings are relevant, as they not only suggest that physical activity improves academic performance, but also that activity enhances the general efficiency of the brain (Hillman, Erickson, and Kramer 2008).

In support of these claims, intervention studies using vigorous aerobic-based exercise reported enhanced performance in a range of cognitive tasks (Davis et al. 2007). The effect seems to be restricted to cardiovascular fitness and does not include muscular strength, which suggests that fitter people have greater cardiorespiratory efficiency and benefit from facilitating the brain functions that positively influence brain plasticity and cognitive function (Cotman, Berchtold, and Christie 2007).

Physical activity and psychosocial factors

Psychosocial factors are the psychological and social aspects of human development. They are often treated as a pair because they are inseparable. These factors influence the educational experience of young people; they can support or hinder success because being successful at school requires students to perform a range of social as well as personal and academic tasks. And, of course, in addition to mastering subject matter and performing well in tests, school is also an important setting for the development of friendships, social identities and a sense of community belonging. The potential number of psychosocial factors is vast. This section focuses on a small number of themes, chosen because of their close relationship with educational achievement.

Self-esteem

Self-esteem indicates the degree to which an individual feels positively about him or herself, and individuals with high self-esteem as individuals that respect themselves, acknowledge their own limitations and expect improvement and growth (Rosenberg et al. 1995). It generally arises when an individual succeeds, is praised, or experiences love from another, and is lowered by failure, harsh criticism and rejection. Self-esteem is associated with emotional stability and adjustment, and low self-esteem features in many forms of mental illness and poor health behaviours (Fox 1999). Self-esteem is often presented as both a marker for general well-being and as an indicator for recovery from personal difficulties. Some psychologists go so far as to say that self-esteem is the core of mental health as it represents a self-rating of overall worth (Landers and Arent 2001).

A widely held belief among both researchers and practitioners is that self-esteem significantly influences achievement in education and other areas of life. Research conducted on the relationship between academic achievement and self-esteem has generally supported a correlational relationship, and a causal relationship between self-esteem and students' future academic and career aspirations has been suggested (Chiu 1990). The persuasiveness of this hypothesis lies in the fact that ability and effort are complements, so that, under the premise that individuals are uncertain about their own ability, higher self-esteem causes better performance in educational assessments. Additionally, many studies have reported positive relationships between high self-esteem and variables that may be assumed to be related to educational achievement, such as greater persistence on difficult tasks, independence and achievement-oriented traits (Baumeister et al. 2003). These qualities are obviously desirable in educational settings, and students who possess the abilities to persist in the face of challenge, work independently and in a goal-orientated way are more likely to perform well at school than those lacking such capabilities.

Physical activity can contribute to self-esteem. Physical competence and appearance (especially among women) are prestigious (albeit in different forms) in all cultures. Competence can lead to a sense of personal effectiveness and feelings of autonomy, and these are associated with the promotion of self-esteem. In fact, among young people, the physical self may be particularly important in the development of self-esteem. Recently, studies have suggested that the situation may be more complex than appearance suggest. Part of the difficulty is that many of the most positive studies have been of relatively low quality. The situation is also confused by the fact that self-esteem can be measured and expressed in a variety of ways (Ekeland, Heian, and Birger Hagen 2005). There is evidence that physical activity can strengthen individual's physical self-worth, and this is an important factor underlying positive perception of oneself, where global (general) self-esteem is assessed, however, findings are mixed (Sonstroem and Potts 1996).

For both boys and girls, the relationship between sport participation and global self-esteem seems to be dependent on peer acceptance, and girls can be particularly vulnerable to negative judgements when participating in sport (Daniels and Leaper 2006). A Canadian study of 16–17-year olds found that, whilst participation had a slight positive association with self-esteem (both physical and global) for boys and girls, more feminine individuals who participated in competitive sports reported lower levels of perceived athletic competence and global self-worth, but reported higher self-esteem when they participated in non-competitive sports (Bowker, Gadbois, and Cornock 2003).

Self-efficacy

Self-efficacy refers to an individual's belief that he or she can execute the courses of action required to obtain a desired outcome. Unlike self-esteem, which reflects how young people feel about their worth or value, self-efficacy reflects how confident individuals are about performing specific tasks. Self-efficacy is specific to the task being attempted, and indicates the extent to which individuals believe they have the skills to succeed. A growing body of research reveals that there is a positive relationship between self-efficacy beliefs and academic performance. Those with a strong academic self-efficacy have a greater willingness to choose challenging tasks, more effective use of learning strategies, less anxiety, enhanced effort and approved academic achievement, compared to those with a weak a sense of self-efficacy (Pintrich, Roeser, and de Groot 1994).

Research has found that regular physical activity can support the development of self-efficacy. A study from Chile evaluated the effects of a school-based physical activity programme on physical fitness and mental health among adolescents. The experimental study found that the programme was associated with increased self-efficacy among the young people (Bonhauser et al. 2005). A similar study from the US measured the physical activity of young people (10–16 years of age) over the course of a week and found that self-efficacy and social influences correlated with more intense physical activity (Strauss et al. 2001). Finally, a high-quality, systematic review found the majority reported physical activity was positively associated with self-efficacy, while a minority saw no effect (Cataldo et al. 2013).

Friendships and peer relationships

Friendships and peer relationships are important for young people's healthy development. Adolescents often spend more time with their peers than with their family members. The development and maintenance of peer acceptance contributes to inclusion in the classroom and play activities, and provide emotional support. They can also affect current and future well-being, and academic achievement (Carroll et al. 2009). Educational achievement, of course, is the focus of this article, and research has demonstrated a significant link between peer relationships and success at school (Ryan and Ladd 2012). For example, children entering kindergarten with existing friends and those able to develop new friendships appear to make better adjustment to school than others (Wentzel and Caldwell 1997). Similarly, Primary-aged and lower secondary-aged students who are not well accepted by their classmates tend to do less well than more popular children, and have a greater risk of becoming disaffected or dropping out of school completely during the secondary years (Woodward and Fergusson 2000). During adolescence, friends influence levels of engagement with school, as well as decisions to spend time studying or socializing.

Physical activity can be a catalyst of developing friendships during childhood and adolescents. Early friendships begin within the context of playing, and physical activity play is the first occurring and most frequent form of such play behaviour. Consequently, frequent and appropriate physical activity play experiences may help young children develop friendships, and it has been found to be especially helpful for those with limited or poor social skills. There is a widely held belief that sport and other socially orientated activities are natural settings for the development of friendships. Sport offers a range of social development opportunities, and friendships with other players have been identified as a primary reason

many young people participate (Denault and Poulin 2009). In addition, participants spend a considerable amount of time together outside of the activity, such as travelling to and from sessions or waiting between competitions. This informal time provides opportunities to share experiences and discuss values and future aspirations. In a seminal study, researchers from the US and Belgium undertook in-depth interviews with a group of sports participants (8–16 years), asking how they perceived friendship in sport. They spoke of the importance of companionship, pleasant play, self-esteem enhancement, help and guidance, prosocial behaviour, intimacy, loyalty, things in common, attractive personal qualities, emotional support, the absence of conflicts and conflict resolution. Participants also acknowledged negative aspects of friendship in sports: conflict, unattractive personal qualities, betrayal and inaccessibility. This study's primary purpose was to map out the dimensions of young people's views of friendship in sport (Weiss and Petlichkoff 1989), but it also highlights the complexity of the issue. However, it is difficult to doubt the importance of physical activity contexts for the development of friendships throughout childhood and youth.

Preventing harmful behaviours

Sexual activity, substance use and psychological adjustment change over the course of childhood and adolescence, and risky behaviours and emotional problems are most likely to appear during early adolescents and continuing to increase over the teenage years (Institute of Medicine and National Research Council 2011). Early drug and alcohol use is associated with lower levels of educational attainment, and young people who begin drinking or using drugs, or who become dependent on alcohol, nicotine or marijuana as teens are less likely to finish college than those who do not use these substances until later in life or never become dependent (Grant et al. 2012). Similarly, adolescent pregnancy and parenthood are major causes for dropping out of school and low educational attainment, even among students with high ambitions (McCarthy and Grodsky 2011).

Sport and other physical activities have often been promoted as constructive alternatives to harmful behaviours. The evidence, however, is mixed. Most studies have found generally positive relationships between out-of-school participation in athletic activities and healthy adolescent development. In terms of risky behaviours like under-age drinking and substance use, teenage sex and similar harmful behaviour, sports participation can be protective for both boys and girls. Girls, in particular, seem to be less likely to engage in these activities (Miller et al. 2005), although some studies have found sports participation related to higher levels of substance use and higher rates of sexual activity for males (Feldman and Matjasko 2005). Perhaps these negative outcomes can be explained by the effects of peer pressure in sub-cultures or by a propensity for risky behaviours. These negative findings do not refer to significant numbers of people, but highlight an inherent danger within some sporting environments. An important influence on whether sports participation is associated with positive or negative behaviours is the length of engagement with the activity, with the greatest benefits coming with greater time (Zaff et al. 2003).

The special issue of competitive team sports

There is evidence of a variety of psychological and social benefits associated with participation in sport during childhood and adolescents. However, recent research has tended to

prioritize the case for physical activity, in general, over sport. This is, in part, in response to the clear shortcomings in some forms of sports provision, such as bullying and other abusive behaviour by adults, overemphasis on competition, a narrow range of activities offered, and a popular perception that competitive sport appeals primarily to boys and young men (Dworkin and Larson 2006).

Whilst not denying any of these concerns, it is worthwhile preserving a place for team sports among the menu of physical activities presented to young people, especially with regard to the psychosocial outcomes they can offer. Research indicates that children who regularly play sport are more likely to be active in adulthood than those who do not take part in childhood sport (Zimmermann-Sloutskis et al. 2010). Child development and health are multifaceted, and different types of activity are associated with different outcomes. So, it is not surprising that there is evidence suggesting young people benefit most from sampling a variety of activities (Côté, Strachan, and Fraser-Thomas 2008), although there may be a danger of over-commitment, where young people pass through a threshold after which the benefits start to reduce. Participation in competitive sport has been associated with positive social and psychological outcomes that would be expected to contribute to success at school, such as: improved self-esteem; self-regulation; goal attainment; and leadership skills (Bailey et al. 2013). These outcomes seem to be closely tied to their social contexts.

Relationships with others are vitally important for healthy child and adolescent development, and sport offers an engaging context for social interactions. Positive involvement in team sports has been associated with warm relationships with coaches, skill development and peer support (Boone and Leadbeater 2006). Additionally, sports participation has been shown to build skills in preparation, persistence and increased sense of belonging (Rosewater 2009). Each of these findings is compatible with the idea that team sport, appropriately presented, offers a positive forum for social connectedness. Some of the benefits from participation in team sports during childhood and adolescents last a long time after individuals stop playing (Bailey et al. 2013). It is important, though, to acknowledge that there are also reasons to question the simplistic presumption that sport necessarily leads to positive outcomes. Although participation in sports contexts can potentially promote healthy development in young people, 'it is best not to take the relationship [between participation and healthy development] as a "given"; it can be difficult to achieve; and can only be realized in association with a series of conducive "change mechanisms"' (Whitelaw et al. 2010, 65). A study from the US provides an interesting example (Dawkins, Williams, and Guilbault 2006). While it is true that there was an association between sports team membership and reduced risky behaviours for some students (specifically black females), for others the pattern was reversed (black males, white females and males). Likewise, a survey of 10,000 middle and high school students found that those who participated in daily sports had higher odds of having intercourse than their peers who did not play a sport daily (Habel et al. 2010). And an analysis of longitudinal data-sets examined the relationships between involvement in high school sports and antisocial behaviours, and found the relationship between athletic involvement and deviance varied, depending upon the behaviours examined.

A significant, perhaps determining, factor in these studies seems to be the social climate in which sports take place. Most of studies treat team sports as a unitary experience, and take no account of the values of the programmes, behaviour of coaches and social environment within teams. This presents researchers and practitioners with something of a

challenge, as positive evidence demonstrates the potential for team sports to contribute to social development, whilst the negative findings highlight the danger of inappropriate or ill-thought-out provision. At the least, this predicament would seem to demand a somewhat more cautious stance when making claims on behalf of team sports than is sometimes the case, but it also highlights the point that values that are embedded in those experiences influence the outcomes of participation. At least in terms of psychosocial development, positive development through physical activities requires teachers, coaches and parents who enforce positive values.

Physical activity and school engagement

School engagement refers to students' sense of belonging, attachment or emotional engagement with the life of the school. Engagement is a motivational foundation of competence, where competence reflects a balance between adherence to social expectations and the achievement of positive outcomes for the individual. In other words, engagement is the pursuit of goals that are both socially and personally important. With respect to schools, this perspective suggests that students are engaged if they pursue goals that are valued by themselves, as well as by teachers, parents and peers. This is an important vehicle for increasing positive outcomes for students, including successful school completion because engaged students achieve more and are happier at school than their disaffected peers (Ackerman 2013). There are, of course, degrees of engagement, but the evidence is strong that those who are motivated to achieve will obtain higher levels of educational attainment, and conversely, low levels of attainment discourage students (Linnenbrink and Pintrich 2002). The most engaged with schooling outperform those who are less engaged or absent because engaged students are likely to exhibit behaviours related to learning, such as concentrating, exerting effort, taking the initiative and being persistent in the face of failure (Hughes et al. 2008).

The problem of truancy and exclusion from school has become serious problem in many countries. The impact of this on educational attainment has been a concern for policy-makers, but there is also a wider concern about the issue. Emerging research evidence suggests that truancy/exclusion has been identified as a significant antecedent to delinquency, dropout and other undesirable outcomes (Maynard et al. 2012). Despite these significant efforts and millions of Euros spent, there is little evidence that any positive impact has been made on school attendance (Attwood and Croll 2006).

Many studies have tested and found empirical support for the claim that students feel more motivated to engage with school and to value what it can do for them when they feel supported by adults, while disconnection from school can lead to disaffection, truancy and dropout (Archambault et al. 2009), as well as increased risk of substance abuse and mental health problems (Bond et al. 2007). To date, few studies have demonstrated a direct association between connectedness and academic achievement, and the most plausible explanation for this is that connectedness alone is not enough; and, students also require teachers who hold high yet achievable expectations.

The interaction between motivation and learning is close, and creates either a virtuous or vicious cycle: good outcomes inspire student motivation, which drives positive outcomes; poor results negatively influence motivation, which in turn influences negative outcomes. The virtuous cycle tends to encourage continued engagement with schooling, while the vicious cycle often results in discouragement, disaffection and dropout (Tinto 1987). Early

intervention is needed that focuses on individual motivation if the vicious cycle is to be broken, and this has been one of the most frequently given justifications for the use of sports-based settings into the educational domain.

School engagement is used here as an umbrella concept for several different components of students' attitudes, behaviours and feelings – psychological; cognitive; and academic. *Psychological engagement* refers to a feeling of belonging with the school, connection to teachers. Time spent in organized sports activities predicts a positive attitude to school and belonging, and higher educational attainment some years later (Fredricks and Eccles 2006). Participants in organized sports experience a greater sense of school belonging and satisfaction, and a negative association has been found between school attachment and unstructured pursuits, such as watching television, or spending time with friends (Blomfield and Barber 2010). Adolescents who participate in sports, performing arts, school-involvement activities or academic clubs have all been found to experience a greater enjoyment of school during the latter part of secondary schooling (Eccles et al. 2003). Extracurricular involvement in a variety of activities has been associated with lower dropout rates and reduced incidence of delinquency and substance use (Mahoney and Cairns 1997). More generally, students participating in leisure activities after-school tend to have positive feelings towards their teachers and other adults.

Cognitive engagement refers to issues of self-regulation and valuing of learning. There is some evidence that young people who are physically active during the school day tend to be more disposed to learn and develop more positive attitudes towards learning and discipline (Keays and Allison 1994). One study used a nationally representative sample of about 1200 public high schools to examine the relationship between school sports participation rates and in-school delinquent behaviours. Results indicated schools with higher proportions of sports participants reported fewer serious crimes and suspensions occurring on school grounds (Veliz and Shakib 2012). Most data in this area were gathered with relatively small samples, so some caution is called for, and, in light of the obvious influence of contextual factors (e.g. school and team ethos, teachers' values and behaviours, money) it is not surprising that a subset of sports participants (especially young men) have been identified as placing lower value on school and being more likely to take part in risky behaviour that may affect their schooling (Fredricks and Eccles 2006).

Finally, *academic engagement* relates to factors like attendance, participation, grades and credits earned. Studies have found that students who participate in sports activities were twice as likely to attend school as opposed to those who did not. A 5-month programme involving attendance monitoring, sports participation and a 'moral character' class found significant differences between intervention and control groups in terms of reduced absenteeism, increased educational expectations, improved attitude toward education and general school engagement. One review examined sports and physical activity programmes designed to address antisocial behaviours such as truancy and more serious crimes. Although the authors acknowledged there was limited evidence, their conclusion was that there was some evidence to support the claim that these activities provided an effective vehicle through which personal and social development in young people can be positively affected (Makkai et al. 2003). It has been claimed that school-sponsored sports programmes can also build the illusive 'school spirit', which might be better translated as school engagement. One study found that sports participation in high school was positively related to a number of

outcomes at and following the end of compulsory schooling, including self-esteem and academic achievement (Marsh 1993).

Physical activity and educational attainment

The discussion has reached the heart of the issue. Educational attainment, such as success in examinations and grades, is highly valued by parents, teachers and policy-makers. There is no doubt that educational achievement relates to later career success, especially among marginalized groups within society (Jacobson and Mokher 2009). The standard position among many decision-makers has been that classroom-based subject areas like mathematics and reading are of the highest value, and it is essential that they are prioritized. A second assumption is that any interference with time for these areas must be resisted. So, schools have found themselves under pressure to squeeze out non-core subjects like the arts and sport, not because they are perceived as unimportant, but because they are of a lower priority in a crowded curriculum space. These practices have been reinforced by parents' fears of the consequences of time away from the academically prestigious subject areas. Consequently, physical education and sport are often relegated to the positions of enjoyable, but frivolous, recreations that distract from the main business of schooling.

Many studies have examined the relationships between physical activity, physical fitness and academic achievement. A particularly relevant and recent study is based on the important Avon Longitudinal Study of Parents and Children, based at the University of Bristol in the UK. This birth cohort study has intensively tracked 14,000 pregnant women, their children and partners over two decades (Boyd et al. 2012). The Avon researchers measured almost 5000 children's physical activity for a week at age 11 with accelerometers. They found that the 11-year-old girls in their sample who were more active were performed better on standardized school tests of English, mathematics and science. Also, those who were more physically active at age 11 did better at school as teenagers, and the most active girls did especially well in science (Booth et al. 2013). Since the researchers adjusted the results to account for factors that could affect school performance, including birth weight, current weight, a mother's smoking while pregnant and the family's socio-economic situation, it seems that physical activity had either a direct or indirect effect of the educational achievement recorded.

The majority of these studies in this area have focused on fitness, and there have consequently been difficulties in separating variables (for example, it might be argued that children from relatively wealthy family have better access to both high-quality physical activity opportunities and high quality schooling). However, more recently, there have been a number of studies examining the effects of both short bouts and sustained physical activity on academic performance (Hillman, Erickson, and Kramer 2008). Overall, studies support the claim that physical activity, in different forms, contributes to academic achievement. Some studies have focused on increasing levels of activity during school physical education lessons, whilst others have introduced it as a separate programme. There is also the phenomenon of classroom physical activity breaks. Even the most cautious commentators acknowledge that significant increases in physical activity cause no harm to achievement in other classroom subjects, despite the fact that they have necessarily had their time reduced (Trudeau and Shephard 2008). Adding time to classroom-based subjects by taking time away from physical activity programmes does not improve performance in those subjects, and is likely to lead to a host of personal and health consequences (Bailey 2006).

A fascinating experiment was carried in with a group of 10- and 11-year children in Vanves, a district of Paris, France in the 1950s. The teacher-researchers ring-fenced 26% of the school day for physical activities. Morning and afternoon, half the children exercised, whilst a control group continued to take part in the standard two hours a week of physical education. Despite the loss of a quarter of classroom teaching time, the academic grades of the experimental group did not worsen, often actually improving. The teachers also reported fewer discipline problems, greater attentiveness in class and less absenteeism. Of course, this was a small-scale study, albeit with a control group. The findings were not published in scientific journals, so they were not exposed to the standard quality measures. In addition, it is always difficult to unpick the relative value and harm done by the multitude of factors experienced by young people. Even if the reported findings are taken on face value, it is impossible to say with any confidence that physical activity was the key factor. If its conclusions turn out to be valid, however, they raise important questions about the standard ways in which schools organize and prioritize their responsibilities.

A number of studies have returned to the same basic question asked at Vanves: What happens if a block of the school timetable is replaced with physical activity? The first of these studies was conducted in Trois-Rivières, Canada, in the 1970s, and tracked more than 500 primary-aged students for 6 years, with control groups being formed from the classes preceding and succeeding classes in the same schools. The experimental classes had an hour-a-day of physical activity, leading to a 14% reduction in time for the other school lessons, while the control classes were taught for the standard 40 min of physical education per week. According to teacher assessments, the overall educational performance of the daily activity group was better than their less active peers. They also scored higher on a standard intelligence test, and in mathematics examinations (although they did less well in English tests) (Trudeau et al. 1999).

There have now been many international studies exploring the question of the relationship between physical activity during the school day and educational performance, and they have tended to come to the same conclusions: replacing a sizeable amount of time for classroom-based subjects with physical activities does not harm performance in those subjects, and in some circumstances seems to result in improvements in grades (Booth et al. 2013). A second set of studies approached the matter from a different angle: How does physical fitness affect educational performance? Physical activity and fitness are related, of course, as fitness tends to be greatest among the most active. However, fitness is an elusive measure as it is impossible to separate the contribution made to fitness from school-based physical activity in school from that which takes place before and after school, over the weekend, and during vacations. Also, children's bodies and brains are in a state of constant change, and older, more physically mature children tend to outperform their younger, smaller peers, anyway (Bailey 2005). Despite these cautions and concerns, numerous studies have found that physically fit children tend to outperform their less fit peers. According to one meta-analysis, increased fitness was associated with better grades in mathematical, reading and IQ scores (Fedewa and Ahn 2011). That it is these particular measures that seem to be most associated with physical fitness is, in itself, intriguing as these are precisely the areas that would be expected to be affected by improved brain functioning (McClelland, Pitt, and Stein 2015).

Consider, too, a study that found that, in the words of its title, 'Schools with Fitter Children Achieve Better Literacy and Numeracy Results' (Telford et al. 2012). The researchers found

that both activity and fitness levels correlated with government tests scores, and that schools with fitter children outperformed the others. The explanation for these outcomes offered by the researchers was that physical activity and fitness are elements of schools that tend to have atmospheres that are supportive of educational achievement and success, and this is plausible. However, there may also be a supplementary account. Many studies report associations between physical activity and physical fitness and academic achievement. It would be a mistake to view this as a disappointing finding. On the contrary, such are the complexities of child development and educational performance that a single factor is unlikely to have more than a weak association (Farb and Matjasko 2012). Educational outcomes are influenced by many forces differentially across various contexts, so physical activity alone should not be expected to have large or consistent effects on educational outcomes. However, the effects of exercise on the brain are almost inseparable with effects of other factors such as diet and sleep. Young people who are fit and active, well fed and well rested are more likely to have a successful school career than those who are not. So, beyond the positive effects associated with physical activity and physical fitness, they should also be understood as part of a synergistic whole that is likely to have a profound effect in shaping the educational, personal and social lives of young people. In addition, positive effects during the early stages of life can lead to multiplied and magnified benefits in the long term (Basch 2011).

The traditional position among many decision-makers has been that classroom-based subject areas like mathematics and reading are of the greatest value, and that it is essential that these areas are prioritized within schools. A second assumption is that any interference with student success in these areas must be resisted at all costs. Consequently, many schools have found themselves under pressure to squeeze out non-core subjects like the arts and sport, not because they are unimportant, but because they are of a lower priority. These practices have been reinforced by parents who fear the consequences of time away from the most prestigious subject areas. So, physical activities, like sport and dance, are often relegated to the positions of enjoyable, but frivolous recreations that distract from the main business of schooling. In this context, it is hardly surprising that every study from the last few decades of the state and status of physical activity opportunities in school – and especially their manifestations as curriculum physical education and sport – has reported serious cause for concern. Some school systems have little or no place for these physical activity experiences. Others keep a place in the timetable, but their quality is undermined by poorly trained or untrained teaching staff, inadequate facilities or a common pattern that when time and money is limited, these are among the first subjects to be cut. There are considerable variations between countries and states, but quality physical activity experiences in their various forms often become pushed to margins, offered as a trivial escape from the main business of the school, or squeezed out of the school timetable completely. This is a concerning situation, as physical activities *can* have significantly positive effects on a range educational outcomes, especially when delivered by properly trained staff and in a positive learning environment.

Conclusion

Physical activity is associated with a range of health risks, both during childhood and in later life. The pandemic spread of sedentary behaviour around the world has been identified as a significant public health risk. Any attempt to address these problems is undermined by

outdated and incorrect views of the relationship between the mind and the body. Nowhere is this clearer than in education. The school is the main societal vehicle for young people's regular physical activity, yet evidence from many countries reveals that many children are inactive (Hallal et al. 2012). The place of physical education and school sport within the curriculum are perennially under threat, and this precarious position is driven by parents' and educators' fears that time given to physical activity undermines performance in classroom-based subjects. Yet, there is no evidence that time dedicated to physical activity interferes with academic achievement. On the contrary, there are reasons to suppose that, assuming appropriate provision, physical activity can contribute to success at school. Put another way, it is simply a mistake to assume that the quantity of classroom experiences determines academic achievement; it is the quality, not the quantity of learning that matters most. Physical activity can enhance the quality of learning at school.

Regular physical activity promotes growth and development in youth and has multiple benefits for physical, mental and cognitive health. This much seems uncontroversial, but it may well be the case that the cluster of positive outcomes that have been identified to be associated with physical activity are the expressions of a more fundamental effect, that improved organic functioning. If this is true, it is hardly surprising that studies have found a relationship between vigorous and moderate intensity physical activity and the structure and functioning of the brain. It would also come some way to explain why young people who are more active show improved self-esteem, greater attention, have faster cognitive processing speed and perform better on standardized academic tests than their less active peers. Of course, academic performance is influenced by other factors, such as parental involvement and socioeconomic status. Nevertheless, ensuring that children and adolescents achieve at least recommended levels of vigorous or moderate-intensity physical activity (the World Health Organisation recommendations for physical activity state that children – 5–17 years – should accumulate at least 60 min of moderate-to-vigorous-intensity physical activity daily, World Health Organization 2010) suggests the improvement of factors that are supportive of educational performance. Whether such a relationship is a causal one is still a contested issue (Hattie and Clinton 2012; Singh et al. 2012a, 2012b). However, to step off the academic fence for a moment, the weight of evidence, especially when measures of quality are taken into account, makes the case for an association (even a causal relationship) persuasive.

It is too soon to develop a causal model, however, but it might be possible to sketch out the early stages of a model. In the words of Keeves (1997, 559), 'the model, like the hypotheses, which are contained within it, can be built from accumulated evidence, intuition by analogy, or derived from theory'. This model describes a framework for investigating the actualisation of measurable outcomes resulting from vigorous and moderate-to-vigorous physical activity. Presented in this way, the model offers a series of testable hypotheses, which could act as foci for subsequent explanatory and predictive theory development.

Figure 2 offers such a tentative model. Based on the evidence reported in this article, as well as the others gathered together in this volume, it is possible to hypothesise certain relationships between key factors that underpin educational achievement. This assumes, of course, the positive relationship between activity in school and performance in tests.

The findings presented in this article suggest that discussions of the importance of young people's physical activity need to be broadened from the conventional discourses of health and disease (which are, of course, of great importance) to consider the contributions that activity makes to the holistic development and functioning of the human being. Active

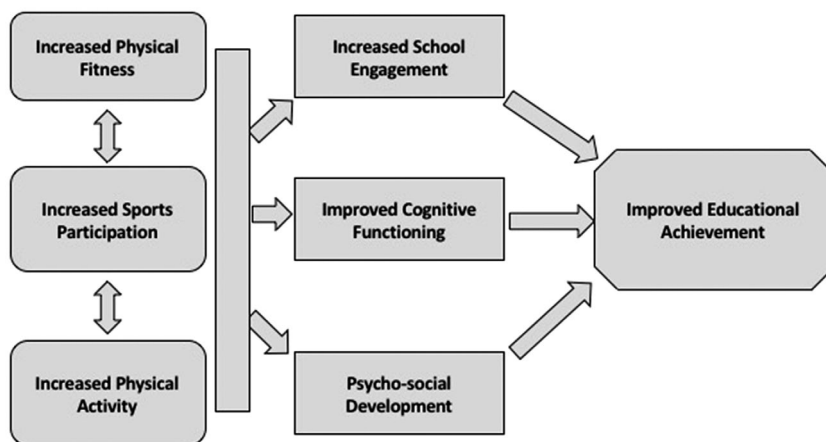


Figure 2. A tentative model of the relationships between physical activity and educational achievement.

young people tend to perform better than their sedentary peers. They tend to perform better at school; on tests; and during their career. It is impossible to calculate the total full advantage offered by these improvements, but it is worthwhile acknowledging that they result from participation in activities that are mostly free, and, when presented appropriately, with which young people will participate in happily and voluntarily. This means that the common assumption that physical activity and classroom learning are necessarily in conflict is mistaken, and educators ought to rethink the planning and delivery of schooling radically.

There are many implications of this revolution for the understanding of the relationship between physical activity and education. The ways in which schools are organized and presented to young people need to change. They are outdated and inadequate since they were designed (more than 100 years ago) with the vision of the child as passive and still, when it is now known that the child is an active and moving learner. Based on the evidence reported here, it can be plausibly claimed that schools need to offer a wide range of positive, attractive physical activities to all students. Movement needs to step out of the gym and infiltrate the whole school day.

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