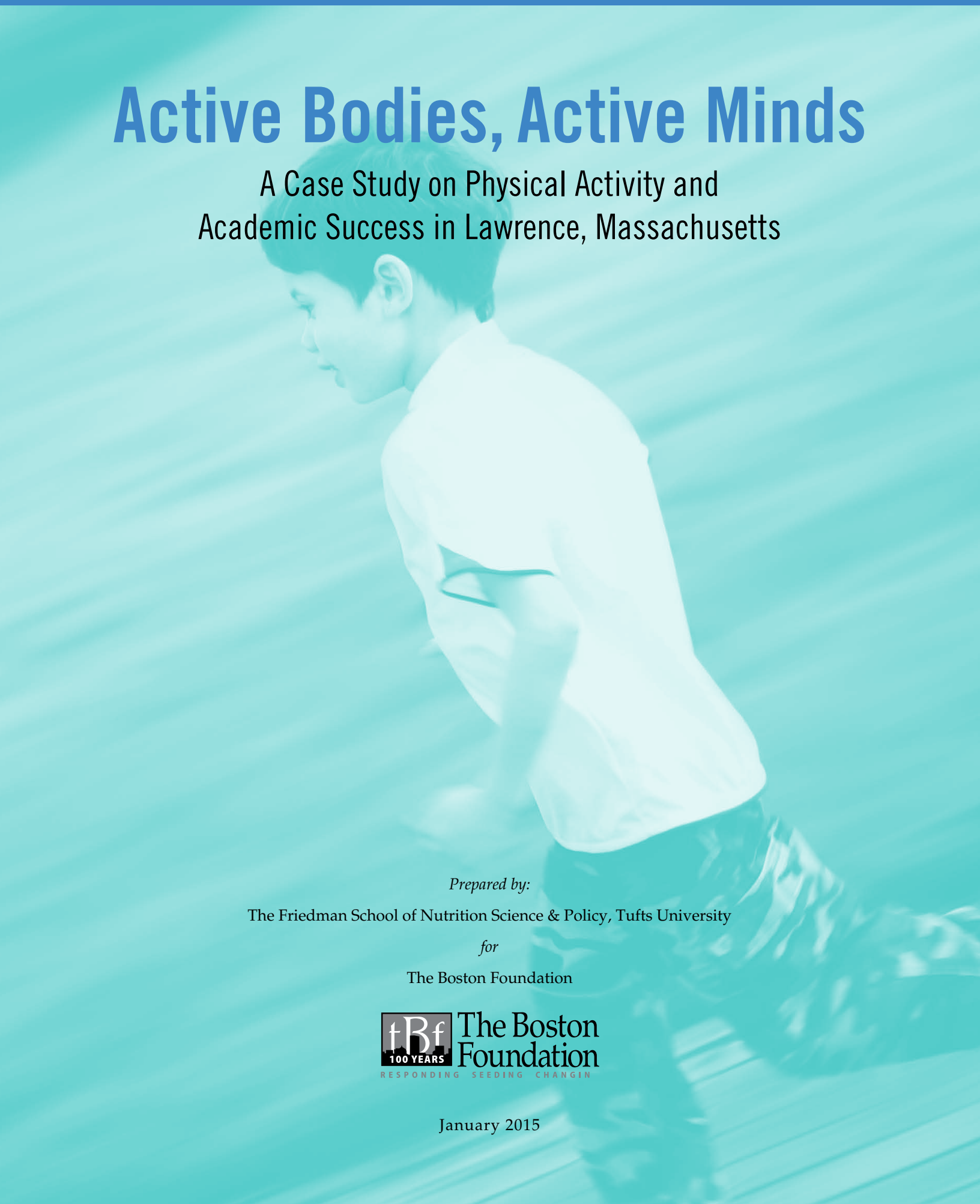
Active Bodies, Active Minds

A Case Study on Physical Activity and Academic Success in Lawrence, Massachusetts



Prepared by:

The Friedman School of Nutrition Science & Policy, Tufts University

for

The Boston Foundation

January 2015

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About The Friedman School of Nutrition Science & Policy at Tufts University

Since 1981, the Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy at Tufts University has been dedicated to improving the nutritional well-being of people worldwide. The school's eight degree programs—which focus on questions relating to nutrition and chronic diseases, molecular nutrition, agriculture and sustainability, food security, humanitarian assistance, public health nutrition, and food policy and economics—are renowned for the application of scientific research to national and international policy. Led by Associate Professor Jennifer Sacheck, Ph.D., FACSM, the team that compiled this report has extensive expertise in community-based research in the fields of nutrition and physical activity. Taking an innovative, transdisciplinary approach, their research has catalyzed change through community-level capacity building, and driven public policy to create and sustain healthy environments. For more information, visit nutrition.tufts.edu or call (617) 636-3728.

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Preface

This case study addresses two major priorities of the Boston Foundation—health and education. Since the 2007 publication of our *Understanding Boston* report *The Boston Paradox: Lots of Health Care, Not Enough Health*, we have worked to draw attention to the epidemic of preventable chronic disease that not only threatens the health of Greater Boston's residents, but drives health care costs so high that they are crowding out investments in all other priorities, including prevention.

In response, the Foundation launched the *Healthy People/Healthy Economy Coalition* in 2010, a broad group of business leaders, health care providers, public health advocates and political and civic leaders with the goal of making Massachusetts the national leader in health and wellness.

While state law dictates that physical education should be a part of the curriculum in all schools, regulations no longer prescribe the amount of time students should spend in physical education classes. As of 2009, almost half of the Commonwealth's public school students were not participating in any physical education classes. In Boston, 30 percent of public schools offer no physical education classes at all. These statistics run counter to evidence-based guidelines that recommend at least 60 minutes of physical activity every day for youth, with at least 30 minutes occurring during the school day. Restoring physical activity to the school day is a crucial step in reducing childhood obesity and improving the overall health of our school-age children.

A recent study by the Trust for America's Health gave Massachusetts the worst score in the country in a measure of physical activity among high school students. Only 17 percent of the state's high school students reported being physically active 60 minutes or more every day. Meanwhile, one in three children in the state is overweight or obese, a rate that has doubled over the last 15 years. These statistics should be seen in the context of national research, which has indicated that academic performance improves and behavioral problems decrease in schools where physical activity is incorporated into the school day.

To begin exploring this issue in depth, we engaged the Friedman School of Nutrition at Tufts University to conduct a study examining the impact of school-based physical activity, its relationship to academic outcomes, and whether such opportunities have equitable reach for diverse school children. We chose the city of Lawrence as the focus of this report, a city that has been making great progress in their public education system in recent years.

This report supports the Foundation's goal of reducing disparities in health outcomes—especially in the areas of obesity and obesity-related preventable chronic diseases. In the future, we will build on this research by conducting a longitudinal study to track the longer-term effects of physical activity on reducing overweight and obesity rates as well as improving the health and academic outcomes of youth. As the title of this report suggests, we believe that active bodies lead to active minds.

Paul S. Grogan
President & CEO

Introduction

The role of physical activity in promoting positive academic outcomes has been a topic of increased discussion and research over the past few years. While the idea of exercising to calm down and focus may seem counterintuitive, a considerable amount of evidence has been generated to demonstrate the positive relationship between physical activity and school performance. At the same time, budget and academic pressures have led many schools to reduce time allotted to physical education and activity during the school day.

In 2012, the Institute of Medicine (IOM) published the *Accelerating Progress in Obesity Prevention* (*APOP*) report, which called for making school-time physical activity a public health priority.[1] Physical activity plays a key role in childhood obesity prevention as well as conferring a number of other health benefits for children.[2,3,4,5] Yet, fewer than half of American children meet the recommended 60 minutes of daily moderate-to-vigorous physical activity (MVPA).[6] Schools are an ideal setting to achieve maximum impact with respect to improving physical activity levels, given the significant amount of time children spend in school over the course of their childhood.[7] Recently, experts have called for a "whole school" approach to increasing children's activity levels. Strategies should include physical education (PE), recess, in-class physical activity breaks and integration of physical activity with the curriculum to create school environments that support equitable reach for all children to attain at least 60 minutes of daily MVPA, 30 minutes of which should be achieved during the school day.[8]

Obesity,[9,10] physical activity and physical fitness[11,12] are associated with academic outcomes, including mathematics and reading test scores.[13] Children who are physically active are better able to learn; they show better school attendance, academic performance, memory and problem-solving skills than their less active and less fit peers.[8,14,15,16,17] Even short bouts of activity have been shown to improve constructs that are predictive of academic achievement,[18] such as concentration and behavior.[19] However, competing demands, such as standardized testing requirements and budget cuts, have led to fewer opportunities for children to be active during the school day.[20] Therefore, research that contributes additional evidence of the association between school-based physical activity and neutral or improved, rather than diminished, academic outcomes, has the potential to influence school administrators' investment in school-based physical activity programs.[21] While legislation was proposed in the Massachusetts legislature in 2013 (Senate bill 246) to mandate 30 minutes of MVPA per school day for all students in K–8 grades, compelling data demonstrating ways to incorporate more physical activity within the school day that may directly impact academic achievement is lacking. The failure of that legislation is proof that states need evidence that investments in health promotion have a positive academic return.

Emerging evidence suggests that the "whole school" approach to increasing time spent in MVPA may be even more critical for underserved children. Compared to children from higher socio-economic status (SES) strata, school-time physical activity represents a greater proportion of total daily physical activity among racially diverse children from low-income communities,[22] highlighting the fact that the promotion of school-time physical activity is particularly important for underserved children. Yet environmental barriers, such as limited policies, activities and infrastructure that support physical activity, have been observed in lower-SES schools,[23,24,25] which can decrease lower-SES children's school-time physical activity opportunities. A recent study found that lower-SES elementary schools were less likely to have PE specialists compared to higher-SES schools, and children achieved only 4–6 minutes of MVPA in a typical 30-minute PE class.[25] Under-resourced schools may face significant constraints to implementing school-based physical activity programs to supplement PE, thereby exacerbating disparities in physical activity, overweight/obesity and academic achievement. However, short activity bursts can influence determinants of future engagement in physical activity, suggesting that just small increases in school-time MVPA could lead to

additional increases in total daily MVPA and concomitant improvements in physical health and academic outcomes in underserved children.

To date, little work has been done to examine how school-based models increase physical activity among populations that are less likely to be physically active. Childhood obesity and physical inactivity disproportionately affect racially/ethnically diverse children and those from low SES households. In the Lawrence, Massachusetts school district, approximately 90% of students are Hispanic, 92% live in low-income households[26], 45% are overweight or obese[27] and many demonstrate academic underachievement. Among sixth-graders, 61% and 58% fall into the "failing" or "needs improvement" ranges on the Massachusetts Comprehensive Assessment System (MCAS) state achievement tests for Math and English language arts (ELA), respectively, compared to 40% and 32% of students state-wide.[28]

In 2011, the Lawrence school district was placed under receivership due to its historically poor academic performance. As a result, the district began to assess the efficacy of different approaches for boosting academic performance, including the implementation of novel programs to increase children's physical activity. After three years of the turnaround effort, the Lawrence district has shown considerable progress, including a significant increase in Math and ELA MCAS scores and an increase in schools designated as Level 1, the highest performance ranking. Despite these continued positive trends, additional work is needed to increase MCAS performance across the district and ensure improvements are sustained.

Given the need for academic improvement and the implementation of novel physical activity programs, the Lawrence school district presented a unique opportunity to further understand the association between physical activity and academic outcomes. The goal of the research outlined in this report was to examine both school-time and total daily MVPA in Lawrence elementary and middle school children. In addition, researchers aimed to better understand school-level environmental support for children's physical activity and its relationship to academic outcomes.

The Research

The overall objective of this case study was to evaluate the impact of the school physical activity environment (policies and programs) on school-time and total daily MVPA to help children meet recommendations. The research hypothesis was that school-based physical activity initiatives and programs have positive effects in multiple domains of child well-being, including total MVPA and academic outcomes. The specific aims were:

Aim 1: To understand how much school-time and total daily physical activity children engage in and if they meet current recommendations.

Aim 2: To understand the schools' physical activity environment and to evaluate whether schools with more supportive physical activity environments are associated with greater school-time and total daily moderate-to-vigorous physical activity in children.

Aim 3: To evaluate whether schools with more supportive physical activity environments are associated with better academic outcomes in children.

Study Population and Data Collected

In the spring of 2014, 451 3rd–6th graders were recruited from eight elementary and middle schools in Lawrence, MA. Recruitment took place during the school day by classroom or assembly-style presentation of the study. Informed assent and consent forms (for children and parents to read and sign, respectively) were sent home in English and Spanish with all interested and grade-level eligible schoolchildren. Consent forms were returned to the school in order for the child to participate in the study. The study protocol was approved by the Tufts Institutional Review Board.

Measures

Child-level data

Socio-demographic data. Parent and child demographic data were collected via a self-administered survey that was included in the recruitment packet. Free- and reduced-price meal eligibility and maternal education were used as indicators of SES. Parents/caregivers were also asked to report whether or not their child had behavioral difficulties, including learning, understanding or paying attention, or communicating, and whether their child was on an individualized education program (IEP).

Anthropometrics. Assessments of height and weight were measured in triplicate and body mass index (BMI) was calculated as body weight in kilograms divided by height in meters squared (kg/m^2) and converted into a percentile and z-score using the Centers for Disease Control and Prevention (CDC) age- and sex-specific growth charts.[29] BMI percentiles were classified accordingly as: < 5th percentile as underweight; 5th- ≤ 85th percentile as normal weight; 85th- ≤ 95th percentile as overweight; and ≥ 95th percentile as obese.

Academic outcomes. The Massachusetts Department of Elementary and Secondary Education provided child-level 2013 and 2014 MCAS Math and ELA standardized test scores and attendance. Scaled test scores were used to determine four levels of performance: Advanced, Proficient, Needs Improvement and Warning. Attendance was assessed as the number of days present per academic year and converted to a percentage.

Measurement of Physical Activity

Instrumentation. Physical activity was measured by Actigraph GT3X+ accelerometers (ActiGraph, LLC, Pensacola, FL), validated and calibrated for use among children.[30] Accelerometers are small devices, worn on an elastic belt around the waist, that capture duration and intensity of movement.

Protocol. Participants were outfitted with an accelerometer by trained research staff at scheduled school study visits. Trained research staff showed participants how to properly wear the accelerometer and provided printed instructions for children to take home. Accelerometers were attached to adjustable elastic belts and worn over the right hip, consistent with previous studies.[6, 31] Children were instructed to wear the accelerometer for seven consecutive days during all waking hours, except when bathing or swimming. The accelerometers were returned to school after seven days and collected by research staff.

Data preparation. Accelerometers were initialized to sample and store activity counts beginning on the first day the participant was instructed to start wearing the device. Stored activity counts from each monitor were downloaded for data reduction and analysis. A day was considered a "valid day" if daily wear-time was greater than or equal to 10 hours. Participants with less than three valid wear days were excluded from the analysis. Counts were classified into the following physical activity intensity categories using the cut points developed specifically for children by Evenson *et al*.: sedentary (≤ 50 counts per 30 seconds), light (51–1148 counts per 30 seconds), moderate (1149–2005 counts per 30 seconds) and vigorous (≥ 2006 counts per 30 seconds).[32] Hour and time of day were inserted on the accelerometer output. Minutes of moderate-to-vigorous intensity were averaged for each participant across three segments: total daily (average of weekdays and weekends), during school and weekday out-of-school. In-school hours were calculated for each participant, based on the specific start and end times of the school day for each day the accelerometer was worn. Weekday out-of-school time was calculated as the sum of before school time and after school time, accounting for school hours and average awake time.

Weather conditions. Weather data were collected from the National Oceanic and Atmospheric Administration.[33] The high temperature (continuous variable) and precipitation (binary: yes/no) were recorded for each day the accelerometers were worn by participants from the weather station nearest to Lawrence.

School-level data

Physical Activity Environmental Scan. The person most knowledgeable about the physical activity environment (PAE, including practices and policies) in each school was asked to complete a brief, 10-item survey, which assessed the physical activity environment at each school. Questions from the PAE survey were adapted from the School Physical Activity Policy Assessment (S-PAPA).[23,34] The survey was divided into sections to assess physical activity supporting policies and practices in four areas relevant to the school environment: PE, recess, classroom-based physical activity and before- and after-school physical activity opportunities. Scores on the physical activity scan were tabulated based on policies and practices identified as being related to children's MVPA during school.[35] For example, a question regarding PE asks about requiring: a) at least 150 min/week; b) 90–149 min/week; c) 60–89 min/week; or d) 0–60 min/week and answering "a" would indicate adoption of the physical activity promoting policy. Total point scores were also either median-split into high- and low-PAE or stratified by percentile (low=10th percentile, medium=50th percentile, high=90th percentile) for additional analyses.

Analyses and Study Findings

A total of 358 schoolchildren had complete study data and were included in the final analytical sample. Participant demographic characteristics are summarized in **Table 1**. Children who took part in this study were representative of the Lawrence School District with the exception of a higher percentage of participating girls. Statistical comparisons, controlling for appropriate covariates, were made for all analyses and statistical significance was set at $p<0.05$. Where results are described as "significant," p-values can be assumed to be less than 0.05.

Table 1. Descriptive Statistics of Study Sample

	Sample size = 358 students
Mean age, years (SD[a])	10.1 (1.2)
Sex	**%**
Male	37.7
Female	62.3
Grade	
3rd	31.8
4th	29.3
5th	21.5
6th	17.3
Race/ethnicity[b]	
Asian	2.2
Black/African American	1.7
Hispanic/Latino	83.5
Non-Hispanic white	4.5
Multiracial/unknown	2.0
Weight status[c]	
Underweight	2.2
Normal weight	53.6
Overweight	19.6
Obese	24.6
Free & reduced lunch price eligible	
Yes	92.8
No	7.3
Highest level of mother's education	
High school graduate/GED or less	57.0
Some college or college degree	43.0

[a]Standard deviation

[b]Does not add up to 100% because of missing data.

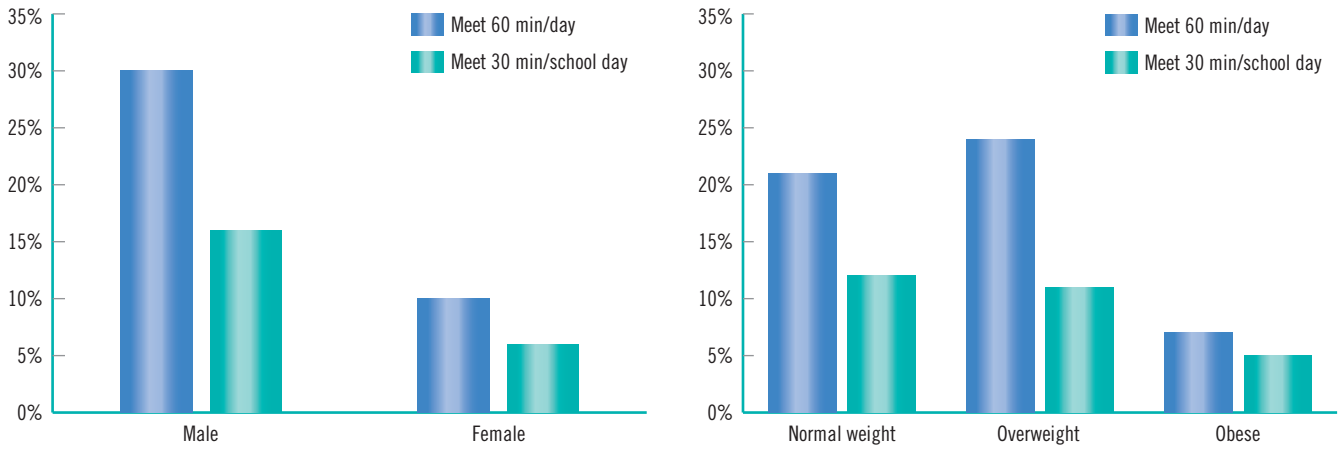
[c]Determined by BMI-z score and percentiles; underweight < 5th percentile; normal weight 5th- ≤ 85th percentile; overweight 85th- ≤ 95th percentile; obese ≥ 95th percentile

The State of Activity

Meeting Physical Activity Recommendations. Few children met the daily and school-time MVPA recommendations. Only 18.2% of children met the recommendation of 60 minutes per day and only 10.2% of children met the school-time recommendation of 30 minutes per day. These levels are much lower than nationally representative data published in 2008 in which 40% of children met the daily recommendation.[6] Nationally representative data on the percentage of children meeting the school-day recommendation has not yet been published. However, in pilot data from some northeastern states (Massachusetts, Vermont, New Hampshire; n=13 schools) gathered in 2013, only 15% and 8% of children met the daily total and school-time recommendations, respectively,[36] demonstrating that the Lawrence schoolchildren are slightly above this regional average.

Of particular concern in this study were the significant gender and weight status disparities observed in children meeting recommendations (**Figures 1 and 2**). In school, 16% of boys met the 30-minute recommendation and only 6% of girls met this recommendation. This significant disparity remains for total daily activity: 30% of boys and 10% of girls met the recommendation. The observed gender disparities are consistent with previous studies and regional work based on objective measures of physical activity in schoolchildren,[36,37] which not only demonstrate significantly less physical activity among girls, but also show an earlier and greater decline in physical activity during early adolescence when compared to boys.[38]

When physical activity by weight status was examined, less than 25% of normal weight and overweight children met the daily 60-minute recommendation,



Figures 1 and 2. Disparities by gender (1) and weight status (2) in meeting daily and school-time physical activity recommendations (60 minutes and 30 minutes of MVPA, respectively)

while only approximately 7% of obese children achieved the recommendation. Similarly, 12% of normal weight and overweight children met the school-time recommendation, compared to only 5% of obese children. The children who were most at risk of not meeting recommendations were the obese girls. Only 4% and 2% of obese girls met the daily and school-time recommendations, respectively. Previous studies based on objective measures of physical activity in schoolchildren also showed that, compared to their normal weight and underweight counterparts, obese children engaged in significantly lower amounts of MVPA.[39]

Translating the percentage of children meeting recommendations to the actual number of minutes in which children engaged in MVPA provides results equally as dire. On average, Lawrence boys engaged in about 50 minutes of total daily activity while girls only achieved about 35 minutes (**Figure 3**). The gender disparity observed holds during school-time. Lawrence boys achieved approximately 20 minutes of school-time activity, while girls engaged in about 14 minutes, a significant school-time difference (**Figure 3**). To put this into the context of what is occurring across the country, nationally representative data from 2003–2006 indicated that 6–11 year old boys and girls accrued approximately 40.3 and 22.8 minutes of school-time physical activity, respectively.[31] More recent, nationally representative unpublished data indicate that these numbers are closer to 25 and 17.5 minutes per day of school-time physical activity for boys and girls, respectively (E. Hennessey/J. Sacheck, personal communication, Dec 2014).

Across weight status categories, both normal weight and overweight children accrued just under 45 minutes of daily activity while obese children only engaged in 34 minutes of daily MVPA. In school, normal weight and overweight children were also similar and engaged in 18 minutes of MVPA, but obese children were only moderately to vigorously active for 13 minutes.

Notably, children should be accruing half of their physical activity time during the school day; however, the amount of activity gained outside of school is currently significantly greater than that accrued during the school day. Contrary to the current findings, nationally representative data from 2003–2006 (that estimated the school-day) indicated that children were achieving most of their MVPA during the school day.[31] Importantly, these researchers found that each additional minute of school-day MVPA is associated with an additional 0.14 minutes outside of the school day, another reason to focus on adding physical activity during the school day here in Massachusetts.

Other Disparities

Nationally, significant declines in physical activity are observed as children get older.[6] Studies have demonstrated a step-wise decline in daily physical activity,[40,41] but this decline has not yet been examined during the school day. School-time physical activity opportunities should have equitable reach across

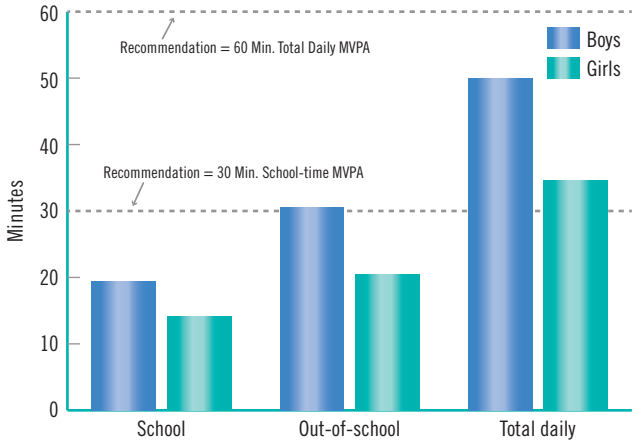


Figure 3. Gender disparities in minutes of MVPA across school- and out-of-school time

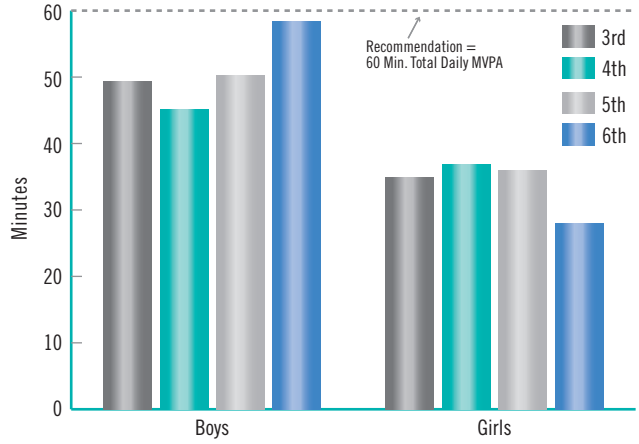


Figure 4. Total daily MVPA minutes by gender and grade

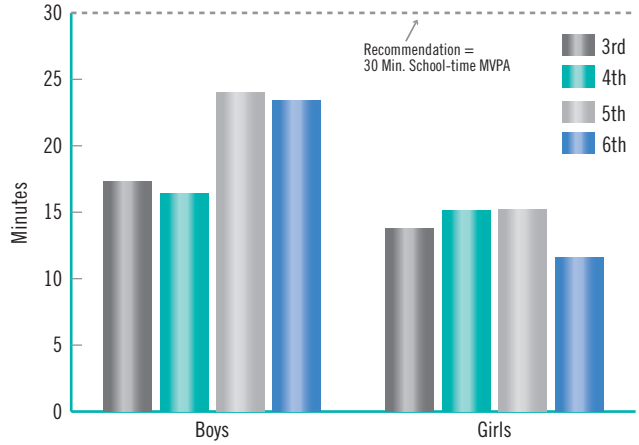


Figure 5. School-time MVPA minutes by gender and grade

grade levels; however, changes in PE time and cuts in recess that occur as children progress through school[42,43] make it challenging to provide equitable reach. **Figures 4 and 5** demonstrate the change in physical activity levels across grades 3–6 for boys and girls. Somewhat surprisingly, there were no changes across grades for total daily activity and only a noticeable decline in grade 6 among girls that that approached significance (p=0.055). These trends were maintained for school-time physical activity; however, for boys, there were significant increases in school-time physical activity in grades 5 and 6. This was likely attributable to innovative programming that is currently being implemented at one of the Lawrence schools (see Spark Academy section).

Racial and ethnic disparities also exist in national data sets, with Hispanic youth demonstrating significantly lower levels of physical activity compared to their white counterparts.[44,45] The Lawrence study population was predominantly Hispanic and thus racial and ethnic differences in physical activity levels were not examined. In regional data, there were no notable racial or ethnic differences in physical activity levels after accounting for other factors such as weight status, gender and SES.[36] In schools, it is noteworthy that physical activity opportunities, although not adequate, appear to have equitable reach across different racial and ethnic groups in these regional data.

Who Is Moving and Why?

The "need to move" is often more apparent in some children compared with others. Teachers may feel that certain children are unable to sit and focus at school, potentially due to behavioral issues or inattentiveness. At the same time, studies indicate that being physically active enables children to focus and be more engaged in the classroom.[46,47,48] In this case study, parents were asked about their child's difficulty with behavior, attention and communication as compared with other children of the same age. They were asked to categorize responses as "none," "a little difficulty," "some difficulty," or "a lot of difficulty." There was a striking direct linear relationship between the minutes of both school-time and total daily physical activity and the intensity of parent-reported behavior problems (**Figure 8**). Notably, children with either "some" or "a lot" of difficulty with behavior were

Spark Academy

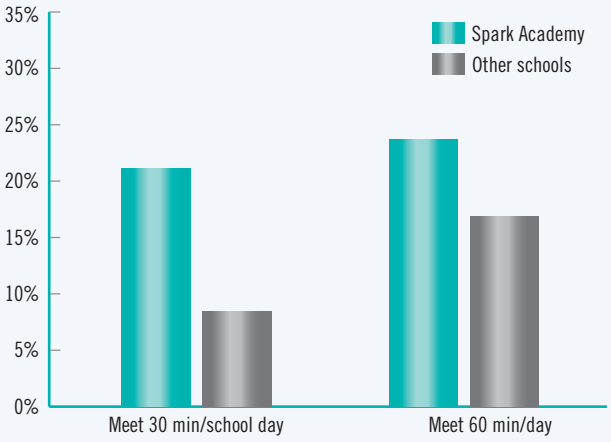


Figure 6. Percentage of children meeting physical activity recommendations at Spark Academy compared to non-Spark schools

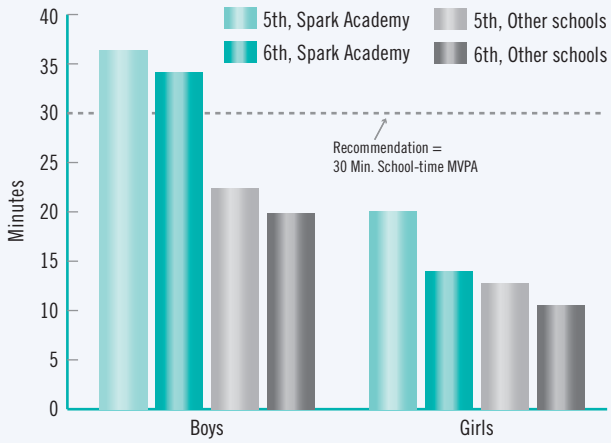


Figure 7. School-time minutes of daily MVPA at Spark Academy compared to non-Spark schools

Spark Academy, which currently serves grades 5 through 7, has adopted a "whole-school" approach to physical activity by integrating physical activity opportunities with academics throughout the day. Since 2012, the public middle school has been gradually replacing one of the lowest-performing middle schools in Lawrence with this innovative physical activity oriented model, adding a new grade each year (next year it will include grade 8). Students have two, 45–60 minute PE and fitness blocks every day. In addition to traditional PE and athletics, students can choose to participate in a variety of other physical activities including dance, karate and cheerleading. Teachers also incorporate short, in-class physical activity breaks during the day.

Fifth and sixth graders at Spark Academy were evaluated as part of this case study during the spring of 2014. Compared to 5th and 6th graders in other schools, a significantly higher proportion of Spark students met school-time MVPA recommendations (**Figure 6**) and accrued more school-time physical activity (**Figure 7**).

Data also show disparities in the amount of school-time MVPA achieved by boys and girls. While boys at Spark, on average, successfully exceeded the 30-minute school-time recommendation and accrued 15 minutes more MVPA than boys in other schools, girls at Spark – as in the other schools – fell well short of the recommendation (**Figure 7**). Fifth grade girls at Spark do seem to have benefitted from the innovative programming, getting about seven more minutes of activity than 5th and 6th grade girls in other schools. However, they do not benefit to the same extent as boys and the effect is mitigated in grade 6.

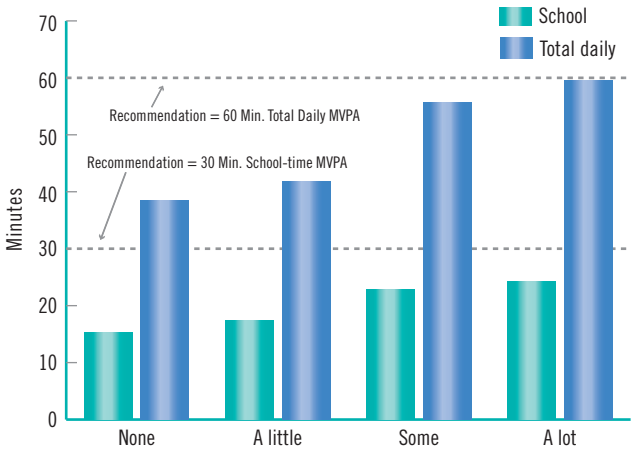


Figure 8. Relationship between parent-reported behavior problems and minutes of school-time and total daily MVPA

very close to meeting both the school-time and daily recommendations of MVPA, and had significantly greater levels of MVPA than those with "none" or "a little" difficulty. Similar linear relationships were observed between both school-time and total daily MVPA and parent-reported attention and communication difficulties (results not shown). These data are a simple snap-shot of an association at one point in time and therefore no definitive conclusions can be drawn about cause and effect. However, these data likely demonstrate that children with behavioral difficulties may need more time to be physically active, both in and out of school. Parents and school administrators should be aware of this relationship and understand the possible need to allocate additional physical activity time for these children.

Key Messages

- Children are not meeting physical activity recommendations, with only 15% and 10% of children meeting the daily 60-minute recommendation and the school-time recommendation of 30 minutes, respectively.
  - This is much lower than the national average but is similar to what is seen in other schools in the region.
- Significant gender disparities also exist, with 16% of boys versus 6% of girls meeting the school-time physical activity recommendation.
  - This gender disparity transcends out-of-school time physical activity levels, with boys achieving on average 54 minutes of total daily physical activity versus 34 minutes in girls.
- Significant disparities exist in meeting physical activity recommendations by weight status, with only 7% and 5% of obese children meeting the daily and school-time recommendations, respectively.
- Children with parent-reported behavior issues engage in more physical activity than those with fewer behavioral issues. This relationship highlights a potential need of these students to have more physical activity incorporated into their school day.

The State of the Physical Activity Environment

Understanding how environments shape individual behavior is critical for the development of policies and programs that can drive change. The brief, 10-item physical activity environmental scan, described previously, was used to better understand how the individual school environment may help shape children's physical activity. **Table 2** highlights the domains assessed and the percentage of Lawrence schools studied that met the highest criteria for a positive physical activity environment (PAE).

All eight schools had indoor and outdoor facilities available for PE and employed licensed PE teachers. Importantly, however, some schools did not require at least 150 minutes of PE per week. In schools that required at least 150 minutes per week of PE, students accrued 21.6 minutes of daily MVPA compared to 15.3 minutes accrued by students in schools that provided less PE; although this difference is notable, this result did not reach statistical significance ($p=0.17$).

Recess characteristics are also important for the promotion of physical activity. Only one third of the schools provided recess that meets the recommendation of at least 100 minutes per week, and students at these schools engaged in significantly more MVPA than students at schools with less recess (18.5 minutes vs. 13.2 minutes). Structural characteristics of recess also

Table 2. Adoption of physical activity promoting policies in participating schools[a]

	Adopted[b] (schools)
PE	%
Requiring all students to participate in PE at least 150 minutes per week	12.5
PE taught by licensed/certified teachers during most or all PE lessons	100
Indoor and outdoor facilities available for PE	100
PE teachers assess student fitness levels annually	62.5
Recess	
Recess is provided to all students for at least 100 minutes per week	37.5
Indoor and outdoor facilities available for recess	50.0
Recess supervision featuring encouragement of physical activity, provision of organized activities, and student to supervisor ratio less than 75:1	0
Classroom physical activity	
Most or all classroom teachers provide physical activity breaks during the school day	0
Before and after school physical activity	
Both before and after school physical activity programs available	0

[a]n=8 schools

[b]Percentage of schools that indicated the most positive adoption of the physical activity practice or policy

demonstrated informative trends. Children in schools that had supervisors who encouraged physical activity, provided organized activities, and had a higher supervisor to student ratio demonstrated nearly significant greater amounts of physical activity (17.2 minutes vs. 12.9 minutes, p=0.06). Having indoor and outdoor spaces for recess were not reflective of greater physical activity levels.

In Lawrence, although classroom breaks were provided by some teachers and before- or after-school programming was available at some schools, none of the schools attained the highest positive score possible in these sections. These findings highlight additional opportunities for schools willing to change their physical activity policies and available programming.

When taking the full physical activity environment scan into consideration (by scoring either high or low on the scan), no significant differences in school-time minutes of physical activity were observed.

In schools with high physical activity support (high PAE, **Figure 9**), boys achieved an average of 4.5 more minutes of school-time physical activity than boys from low PAE schools, though results were not statistically significant (p=0.124). The current physical environment indices measured by the physical activity scan do not appear to help increase physical activity among girls, as girls attending both low and high PAE schools had similar levels of physical activity.

Key Messages

- Schools are promoting positive PE environments, but more schools need to work toward meeting the current recommendation of providing at least 150 minutes per week.
- Schools providing PE for at least 150 minutes per week and structured recess had the highest school-time MVPA.
- Recess, classroom physical activity, and before- and after-school programming are areas of greatest opportunity and need to improve the physical activity environments of the schools studied.

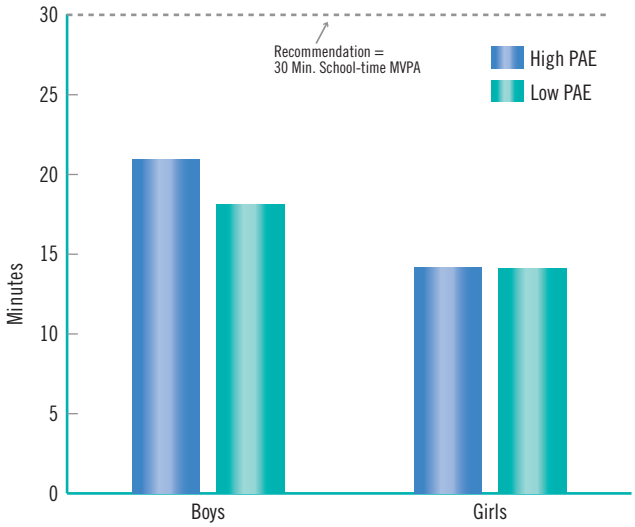


Figure 9. High and low physical activity promoting environments (PAE) and the relationship to children's school-time MVPA

How Environments Can Shape Minds

Many factors are involved in the promotion of academic achievement, and providing children adequate time to be physically active during the school day, along with expressly promoting fitness, are two important factors that need to be considered. Despite substantial evidence of the positive impact of MVPA on academic outcomes,[16] PE time has been dramatically reduced in many schools in response to budget cuts and amidst significant pressure to improve achievement on standardized tests.[49] Nationally, less than half of students attend any PE in a given school week.[50] This is often more dramatic in low-SES schools, which are less likely to have physical activity supporting policies and practices,[23] further perpetuating and exacerbating health disparities.[24]

In research conducted in Cambridge, Massachusetts in 2009, positive relationships were observed between physical fitness and standardized tests scores in Math and ELA.[51] Recently published data demonstrated direct cognitive benefits, including improved executive functioning skills, in children who participated in an after school physical activity program, compared to children who were not in a program that explicitly encouraged physical activity.[52] Yet even with increased attention to data showing the positive relationships between physical activity, cognitive functioning and academic achievement, school administrators are reluctant to "sacrifice" learning time for additional recess minutes, activity breaks, or time spent in PE.

Lawrence Public Schools have made efforts to incorporate more activity during the school day. Spark Academy is a model of the "whole school" approach to physical activity incorporation and other schools have implemented national programming such as Playworks and BOKS (Build Our Kids' Success). Playworks specifically targets supervised play at recess time and BOKS offers before-school physical activity programming. Both are known for their positive impact on children's movement and well-being.[53,54]

Individual MCAS scores from 2013 and 2014 were examined in relation to the school physical activity environment. **Figure 10** shows that children from schools with a high PAE score had significantly higher scores on both Math and ELA, a trend that is consistent across 2013 and 2014. Rates of passing English increased for children in high and low-PAE schools

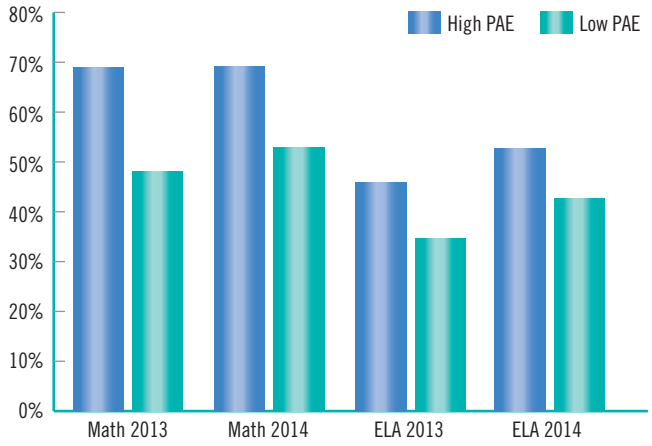


Figure 10. Physical activity environment (PAE) and percentage of students with proficient or advanced MCAS scores

from 2013 to 2014, but remained higher for the highly supportive schools. School attendance did not appear to be impacted by PAE. There were similar increases in attendance from 2013 to 2014 in both low- and high-PAE schools, with the average attendance rates increasing from 95.2% in 2013 to 96.6% in 2014 (data not shown).

Using 2014 data, children in schools with highly supportive physical activity environments were 2.4 times more likely to achieve "proficient" or "advanced" scores on the 2014 MCAS Math section after controlling for factors such as gender, grade, weight status and SES. This relationship did not exist for ELA. **Figure 11** illustrates the predicted distribution of students' performance on the Math MCAS exam if they had a school PAE score that was low, medium or high. For example, it is predicted that in a high PAE school, 67.7% of students would achieve "proficient" or "advanced," while only 32.3% would score "needs improvement" or "warning." Conversely, a low PAE score predicts that only 56.9% of children would achieve "proficient" or "advanced," while 43.1% would score "needs improvement" or "warning." As these are just predicted relationships based on data at one point in time, we cannot say that the school physical activity environment is necessarily driving this change. However, these data do suggest that schools that provide more supportive environments, through policies, infrastructure and programs that encourage children's health and well-being, are linked to better performance on standardized test scores.

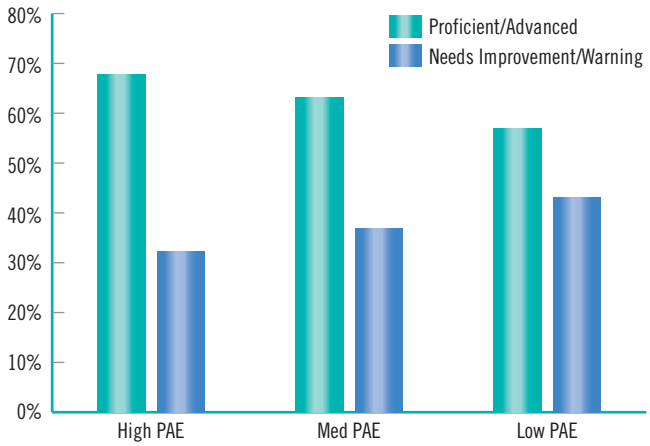


Figure 11. Predicted probability of having Math MCAS outcomes by category based on school physical activity environment (PAE)

When these individual physical activity environmental factors were examined for relationships to academic achievement, several interesting trends emerged. Annual fitness testing and greater amounts of recess provided to students were both positively associated with greater attainment of "advanced" or "proficient" on Math MCAS. In fact, annual fitness testing was associated with children having 1.9 and 2.2 higher odds of achieving "advanced" or "proficient" on Math and ELA, respectively. Offering classroom physical activity breaks also showed a trend toward students achieving better Math scores (p=0.058). These indicators of physical activity promotion may be important factors for schools to consider as methods to not only bolster time spent in physical activity, but also to simultaneously promote positive academic outcomes.

Key Messages

- Children attending schools with greater support for positive physical activity environments were 2.4 times more likely to achieve "advance" or "proficient" on Math MCAS.
- Children attending schools with greater support for positive physical activity environments scored higher on both Math and ELA MCAS in 2013 and 2014.
- Children attending schools that require annual fitness testing were more likely to achieve "advanced" or "proficient" in both math and ELA.

Study Limitations

The research presented in this report was conducted in Lawrence Public Schools in Lawrence, Massachusetts and therefore the findings are specific to this community. However, from the limited data in this field, we do know that the physical activity amounts, patterns and disparities described are likely representative of Massachusetts schools on average. Also, because these data were collected at a specific point in time, the relationships examined in this report are associations and not evidence of causality. Data were collected and examined with rigor using objective physical activity measures including controlling for confounding factors such as SES and demographic variables where relevant. The demonstration of relationships, such as those found in this study, are an important first step in drawing attention to the issues at hand. Lawrence is a community undergoing significant change and trying a variety of innovative strategies to improve academic achievement. We were not able to fully examine changes in the home environment or the school food environment, new classroom curricula, or teaching strategies, all of which can impact academic outcomes. Some of these changes may have occurred alongside changes in the physical activity environment, which may be indicative of a school environment, which may be indicative of school environment that is better resourced in a number of ways, including for physical activity, that are related to the academic findings.

We found relationships between MVPA and the school physical activity environment, and the physical activity environment and standardized test scores, but we did not find a direct link between MVPA and standardized test scores in our sample. A potential explanation for the absence of this relationship is that the most active school, Spark Academy, is providing schoolchildren with more physical activity, but is also one of the lowest academically performing schools in the district. This may also be true for other schools that have recently added additional physical activity programming. This finding based on cross-sectional data underscores the need for longitudinal studies: schools need to be evaluated prior to, and for years following, such interventions to explain these important relationships. Clearly, additional research is needed to better understand the underpinnings of academic success.

Study Implications

The first national report card on physical activity for children and youth, which was released in April 2014 by the National Physical Activity Plan Alliance and the American College of Sports Medicine, found that only about one quarter of children ages 6–15 meet recommendations for physical activity.[55] The Report Card gave the U.S. a D- for overall physical activity and a C- for school-based physical activity. The Lawrence case study demonstrates these suboptimal trends locally, and also provides more detailed measures of physical activity both during and out of school. These findings can begin to fill the current dearth of data in schoolchildren's daily physical activity patterns. Studies often focus on either total daily physical activity[6,37] or school-time physical activity only.[56] Simply stated, as evidenced by this study and others, children are not close to meeting current school-time and total daily physical activity recommendations, and this could have multiple deleterious impacts on children's health and well-being.

In addition, few studies have analyzed specific physical activity disparities that exist during the school day. Research literature has highlighted that females, obese children and racial/ethnic minorities may engage in less daily physical activity.[39,44] However, it might be expected that in a school environment, all children would be exposed to and engage in similar physical activity opportunities. The data presented in this report suggest otherwise and highlight the great need to focus on ameliorating gender disparities that currently exist. Societal perceptions, shaped by increased equality among genders, may lead to inaccurate assumptions. As a society, there may be a sense that "times have changed" and that females, especially young girls, are given more opportunities to be physically active and that they are able to fully take advantage of these opportunities. Even with more opportunities in place, girls still accrued 15 fewer minutes of daily MVPA than boys and only 6% of girls met school-time recommendations. A similar disparity exists for obese children and should be addressed given the additional health risks of obesity that can be attenuated with physical activity. On a positive note, the present study indicated that overweight children, who were a significant portion of the study sample, were equally as active as normal weight children.

Many states have started to enact laws that require schools to provide a certain number of minutes of physical activity and/or certain intensity levels of physical activity. Massachusetts is currently not one of those states. Physical activity programming exists in Lawrence, and is even heavily invested in, as demonstrated by the Spark Academy; however, room for improvement remains in most schools. As such, there is an urgent need for innovative programming that touches the "whole school" – not just during PE, but also during recess, in classrooms and before and after school. While most schools do well in one of these categories, few excel in many. The Spark Academy is an example of how a school can successfully prioritize and integrate physical activity into the school day and help children reach their physical activity goals. However, girls at the Spark Academy are still not meeting recommendations, highlighting the need for further improvements in physical activity programming.

A systematic review of 50 studies on the relationship between physical activity and academic performance found that the majority demonstrated a positive relationship between these measures,[57] including enhanced academic focus and better classroom behavior.[58] Key policies that were associated with greater physical activity in the present research include requiring at least 150 minutes of PE per week, and providing ample recess with added structure and monitoring. Many of the same policies, as well as requiring annual fitness testing, were associated with academic achievement in these children.

Future research should focus on ways to bring novel physical activity programming into schools, including through the development and evaluation of interventions, to support children's physical activity without compromising instructional time. Longitudinal studies are needed to evaluate the impact of these kinds of programs over time, on both children's health and well-being (both physical and cognitive), and on academic outcomes including standardized test scores and attendance. Finally, the findings of the the Lawrence study highlight the importance of identifying strategies to ensure that school physical activity programs and policies reach all children equally, including both boys and girls and children across all weight categories.

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Acknowledgments

The Tufts University research team (Jennifer Sacheck, Ph.D., Catherine Wright, M.S., Virginia Chomitz, Ph.D., Christina Economos, Ph.D., and Kenneth Chui, MPH, Ph.D.) would gratefully like to acknowledge all of those who made this work possible. Thank you to Lawrence Superintendent Jeff Riley, all of the participating schools and students, and Raisa Carrasco-Velez, who was an amazing champion of this work. We would also like to thank all of the Tufts University and Northeastern University students who assisted with data collection and data entry. Finally, but not lastly, we would like to thank Allison Bauer and the Boston Foundation and the New Balance Foundation for not only financially supporting this research, but also championing this cause in Boston and across Massachusetts.