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Exploring the Link between Physical Fitness and Academic Achievement

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Introduction

Health practitioners, policy makers, educators, and community advocates have pointed to childhood obesity as one of the greatest modern day public health crises. In 2005-06, 16% of children and youth ages 2-19 nationwide had a body mass index (BMI) high enough to categorize them as obese, and another 10% were at risk of obesity (Ogden, Carroll, & Flegal, 2008). Childhood obesity is associated with a host of negative health outcomes that were once thought only to affect adults, including Type II diabetes, high blood pressure, and high cholesterol. Recently, research has begun to link childhood obesity to non-health outcomes. For example, studies have established that overweight and obese children have academic outcomes that are worse than their more physically fit peers (Castelli, Hillman, Buck, & Erwin, 2007; Datar, Sturm, & Manabosco, 2004). Furthermore, obese children, particularly girls, have lower self-esteem and are more likely to be dissatisfied about a variety of aspects of their lives (Braet, Mervielde, & Vandereycked, 1997; Strauss, 2000). Although there has been much attention devoted to the negative consequences of obesity among children and youth, there is also a smaller body of literature focusing on the converse – the positive role that physical fitness can play. For instance, there is evidence linking higher levels of physical fitness, which includes fitness measures other than BMI, with better academic outcomes (Grissom, 2005) as well as improved self-confidence (Marsh, 1993).

In this brief, we also focus on physical fitness and examine its relationship to students' academic growth over a period of four years. Using data on students in California's Redwood City School District (RCSd) and Sequoia Union High School District (SUHSD), we follow students across four consecutive years to study the link between physical fitness and academic outcomes. We conclude with a set of implications for policy and programming at the local level.

We address the following three research questions:

1. What are the characteristics of students who maintain physically fit or unfit status as well as those who become more or less fit over time?
2. After controlling for key factors that may affect academic performance, do students who are consistently physically fit have higher test scores over time than those who are consistently unfit?
3. Are improvements in physical fitness over time associated with improvements in test scores?

Measuring physical fitness among California youth

We measure physical fitness using the California Physical Fitness Test (PFT), which consists of six measures of fitness, called Healthy Fitness Zones (HFZs), as outlined in Exhibit 1. Students take the PFT in grades five, seven, and nine, and from this we create two cohorts of students – those taking the PFT in fifth and seventh grades and those who take the PFT in seventh and ninth grades. Combining RCSD and SUHSD data, we identify a total of 1,957 students who completed all six HFZs in either fifth and seventh or seventh and ninth grades. We divide students into four PFT pathway groups:

- Passed five of six HFZs in both academic years;¹
- Passed five of six HFZs in the first academic year but not the second;
- Passed five of six HFZs in the second academic year but not the first; and
- Did not pass five of six HFZs in either year.

Do student characteristics differ based on physical fitness level?

As is shown in the first line of Exhibit 2, almost half the students (49%) pass five of six PFT healthy fitness zones in both years. A quarter (24%) do not pass five of six zones in either year examined, and the remaining quarter transition between passing and not passing during the time period examined.

Overall, many more students pass both PFTs than fail both or even one PFT. Of the 1,957 students included in the analysis, 954 (49%) passed both PFTs compared to only 459 (24%) who failed both. However, we find that there are some differences in background characteristics among students in the four PFT pathways shown. A higher percentage of females passed both PFTs compared to males (50%

compared to 47%), but males were slightly more likely to improve from failing to passing (18% compared to 12%). In addition, higher proportions of students who were Latino, received Special Education services, or were English language learners failed both PFTs compared to the overall student population. Also, disproportionate percentages of students from lower socio-economic backgrounds—those receiving Free and Reduced Lunch and those whose parents did not complete high school—failed both PFTs. Finally, students who scored proficient in math or ELA also performed well on the PFT, with approximately 60% passing both PFTs.

Exhibit 1. Healthy Fitness Zones in the California Physical Fitness Test		
Zone	Healthy Fitness Zone	Type of Test
1	Aerobic Capacity	PACER, One-Mile Run, Walk Test
2	Body Composition	Skinfold Measurements, Body Mass Index
3	Abdominal Strength and Endurance	Curl-Up
4	Trunk Extensor Strength and Flexibility	Trunk Lift
5	Upper Body Strength and Endurance	Push-Up, Modified Pull-Up, Flexed-Arm Hang
6	Flexibility	Back-Saver Sit and Reach, Shoulder Stretch

Is there a connection between physical fitness and academic achievement?

We compare academic outcomes across the four PFT groups using scores from the California Standardized Test (CST) in math and English Language Arts (ELA). Students take the CST in math and ELA every year starting in second grade, so our analyses include four years of CST results for each student. To make the scores comparable across grades and years, we convert all CST scores to percentiles, which give students’ scores relative to their peers in the same grade and year. Because the PFT groups have very different background characteristics and we would expect those characteristics to affect both academic achievement and fitness, we cannot simply compare

¹ Throughout this brief, we define “passing the PFT” as passing five of the six zones, which is the measure that the California Department of Education’s uses to determine whether a student is fit enough to be exempt from physical education classes in high school.

Exhibit 2:
Demographic Characteristics and Baseline CST Performance, by PFT Pathway

	<u>PFT Pathway</u>				
	Pass Both	Fail→Pass	Pass→Fail	Fail Both	Total Number of Observations
Cohort					
5th to 7th Grade	46.5%	16.4%	12.1%	25.0%	1,158
7th to 9th Grade	52.1%	13.3%	13.5%	21.2%	799
Gender					
Male	47.2%	17.8%	10.3%	24.8%	1,002
Female	50.4%	12.4%	15.2%	22.1%	955
Ethnicity					
White	63.2%	12.4%	9.7%	14.7%	631
Latino	41.6%	16.4%	14.2%	27.8%	1,130
Asian/Filipino/Pac Islander	44.9%	16.3%	14.3%	24.5%	142
African American	38.8%	18.4%	10.2%	32.7%	49
Special Education	35.4%	18.2%	16.7%	29.7%	209
English Language Learner	31.3%	17.2%	15.9%	35.6%	441
Free or Reduced Lunch	38.3%	17.2%	15.1%	29.3%	978
Parent Ed Less than High School	37.8%	16.1%	15.6%	30.5%	508
Math CST Proficient or Above	60.0%	14.2%	10.2%	15.7%	894
English CST Proficient or Above	62.8%	14.4%	9.3%	13.6%	752
Overall	48.7%	15.1%	12.7%	23.5%	1,957

CST scores for the fitness groups. Using regression analyses, we are able to calculate the effects of fitness on students' CST percentiles apart from the effects of other student characteristics. These analyses tell us both the average initial scores of students in the first year of our analysis as well as the average rate of growth over time for students in each fitness group.² Thus, we are able to compare the percentile scores that we would expect across four years for students who differ only in their PFT performance.

Even after taking into account background characteristics, students who pass the PFT in both years perform better academically than those who fail both PFT tests. As Exhibits 3 through 6 show, students who pass both PFTs have initial math and ELA CST test scores that are higher than students who fail both times, and these gaps persist through the four years over which we track students. Among

² We use individual growth models, which are a specific type of regression model that utilizes hierarchical linear modeling (HLM) to measure the trajectory of individual students' test scores over time. These models control for individual and school-level factors that research has suggested can influence achievement.

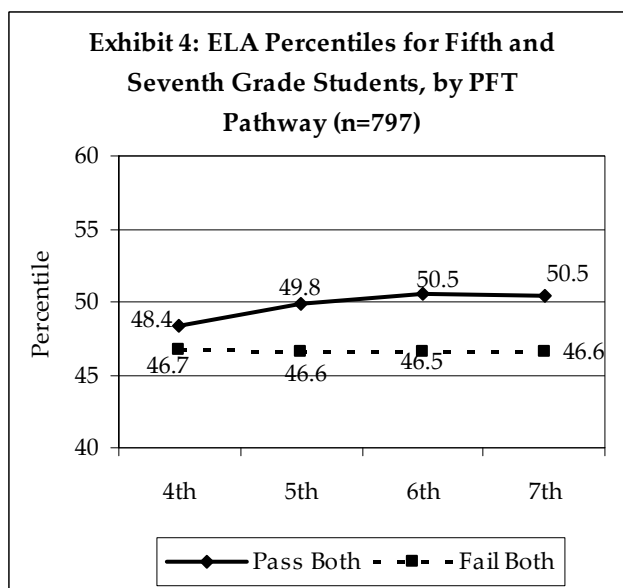
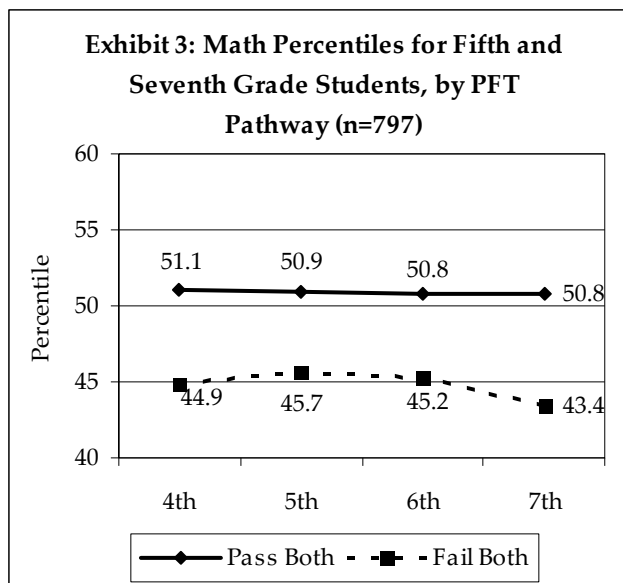
the fifth- to seventh-grade cohort, those who pass the PFT in both years have math CST scores that consistently rank about six percentile points higher than students who do not pass the PFT in both years (Exhibit 3). On the ELA test, there is less initial difference between the students who pass both PFTs and those who fail both, but the gap between the scores increases as students progress through school (Exhibit 4). Exhibits 5 and 6 show a similar pattern when comparing score trajectories for students with seventh- and ninth-grade PFT scores, although the gap in ELA scores between students with seventh- and ninth-grade PFT scores is more consistent as students progress through grade levels.³

In analyses not shown in these graphs, we separately examine the link between fitness and academics for males and females as well as White and Latino ethnic groups. We find similar patterns for all gender and ethnic groups in math scores but some differences in

³ Because students may take different CST end-of-course assessments in math starting in eighth grade, we use only students who took the algebra CST grade for the upper grade cohort comparisons in math to ensure equal comparisons. These analyses are displayed in Exhibits 5 and 9.

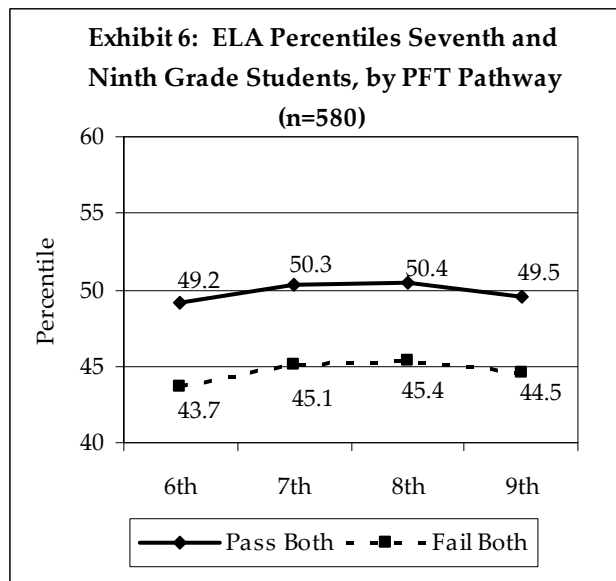
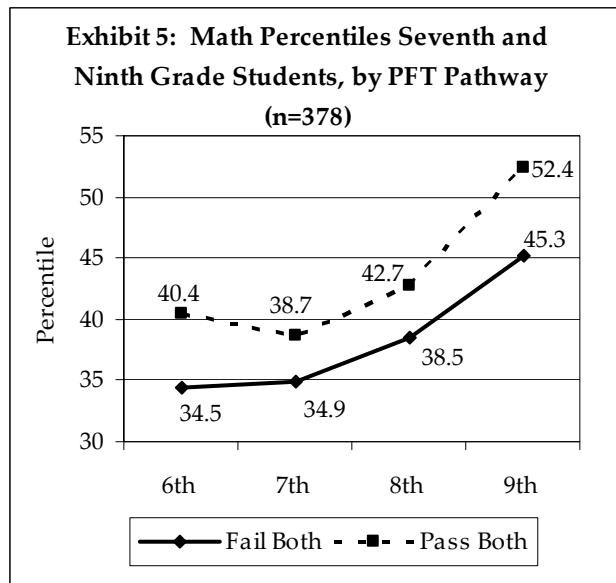
ELA scores. In particular, the growing difference in ELA scores among the fifth to seventh grade cohort (Exhibit 4) is only apparent when comparing fit and unfit girls. In addition, physical fitness has a weaker link to CST scores among older Latino youth.

approximately a one percentile point difference in fourth-grade CST scores between those who move from failing to passing and those who move from passing to failing, but this gap widens over time. By seventh grade, students who switch from failing to passing the PFT score 2.5 percentile points higher in math and five points higher in ELA. The increasing gap between those moving from passing to failing and failing to passing the PFT is particularly apparent among male and Latino students.



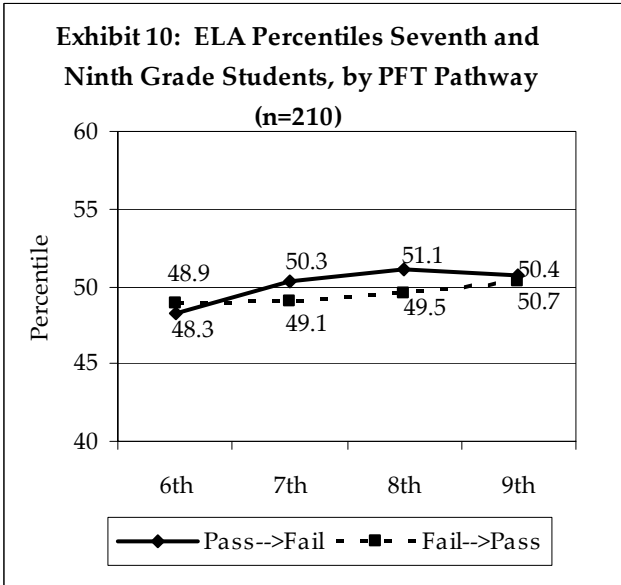
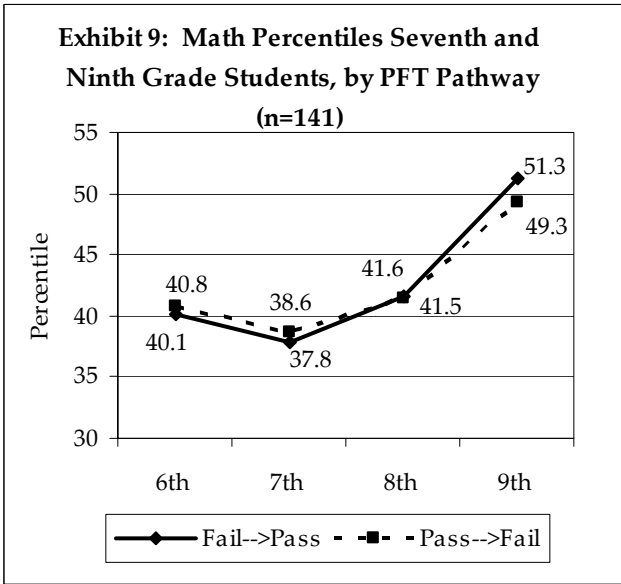
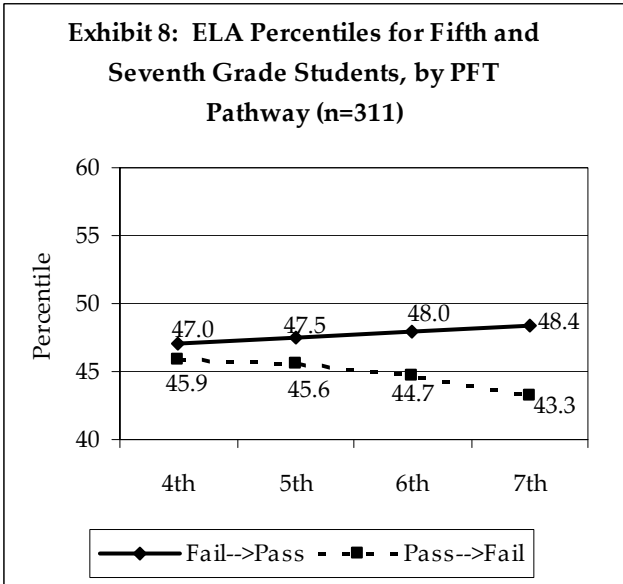
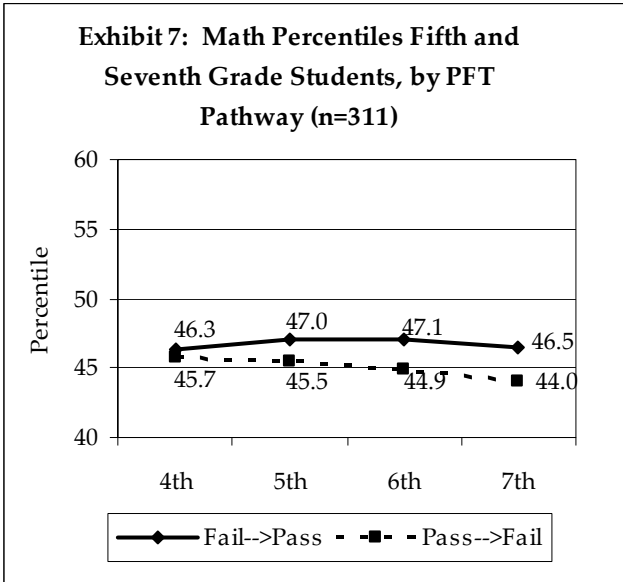
Is improving physical fitness associated with improved achievement?

Students who improve their physical fitness generally do slightly better academically than students whose fitness declines. Exhibits 7 through 10 show findings for the students who transition between failing and passing the PFT. For students in the fifth- to seventh-grade cohort, there is



Exhibits 9 and 10 show that there is almost no overall difference in CST scores among the pass-to-fail and fail-to-pass groups for students progressing from

sixth to ninth grade (Exhibits 9 and 10). However, females who improved from failing the PFT in seventh grade to passing in ninth grade scored higher in both math and ELA than females who went from passing to failing. We found no differences when looking separately at Latino and White students who switched their PFT status between seventh and ninth grade.



What are the characteristics of students who do not fit the mold – those who are physically unfit with high achievement or physically fit with low achievement?

Although there is a strong and consistent pattern of physically fit students performing better on the CST than students who are not physically fit, there are students for whom physical fitness and academic achievement do not correlate in this way. We examine higher-achieving students – those who score at or above proficient in both math and ELA in both years – and find a total of 76 students (5% of students in the two cohorts) who failed both PFT tests. Similarly, a total of 197 students (14% of students in

Exhibit 11:
Characteristics of Students Who Fail or Pass Both PFTs, Overall and by Academic Achievement

	<u>Fail Both</u>		<u>Pass Both</u>	
	Students not Consistently Proficient	High Achievers	Students not Consistently Proficient	High Achievers
5th to 7th grade cohort	61.6%	71.1%	54.3%	56.9%
7th to 9th grade cohort	38.4%	28.9%	45.7%	43.1%
Male	55.1%	48.7%	53.3%	56.9%
Female	44.9%	51.3%	46.7%	43.1%
African American	2.9%	6.6%	2.0%	2.0%
White	15.7%	43.4%	11.7%	49.7%
Latino	74.2%	39.5%	82.2%	40.7%
Other Ethnicity	7.3%	10.5%	4.1%	7.7%
	0.0%	0.0%	0.0%	0.0%
Special Education	15.7%	2.6%	21.8%	4.1%
English Learner	42.3%	0.0%	56.3%	3.6%
IFEP	5.2%	11.8%	0.0%	7.4%
RFEP	30.8%	30.3%	21.3%	30.8%
EO	24.8%	57.9%	22.3%	58.3%
Free or Reduced Lunch	68.4%	32.9%	70.1%	31.3%
Parents did not complete high school	40.5%	9.5%	39.8%	15.3%
Parents completed high school	43.6%	52.7%	48.5%	38.0%
Parents attended college	15.9%	37.8%	11.7%	46.7%
Total Number of Observations	383	76	197	757

the two cohorts) passed both PFT tests but did not score at or above proficient in math and ELA. As Exhibit 11 shows, the socio-economic status of these students differs greatly from that of students with the same fitness level. Those who are unfit but scored proficient in math and ELA are more likely than other students who failed both PFTs to be white (43% compared to 16%) and have parents who attended college (38% compared to 16%). They also are much less likely to be English language learners (0% compared to 42%), and receive Free or Reduced Priced Lunch (33% compared to 68%). The pattern is the same when looking at the opposite extreme. Students who are not high-achieving but physically fit represent a more socio-economically disadvantaged population. These data suggest that socio-economic advantages might mediate the negative effects of poor fitness on academic outcomes.

Is there a connection between specific Healthy Fitness Zones and achievement?

Although one might expect that scores on harder-to-pass HFZs like BMI, aerobic capacity, and upper body strength would be more telling measures of fitness than the overall measure of pass or fail, we do not find a stronger relationship with academic outcomes and any of these measures than we do with overall PFT scores. Similar to our analyses of overall PFT performance, students who passed any one of these zones in both years had higher CST scores than students who failed in both years. However, when we follow students' performance on these three zones, we find that improvements in any one of these areas are not consistently associated with changes in CST scores, although we do see lower CST scores for students whose performance on the mile run decreases. These analyses suggest that it is important to look at overall fitness, instead of just a single

measure, when assessing potential health risk factors that could affect academic performance.

What are the policy implications of this study?

This analysis of physical fitness and academic achievement finds a strong link between students' health and their academic performance. Following children over four years, we find that students who are consistently physically fit are already doing better academically in fourth grade – a year before they even take the PFT – than those who are consistently unfit. Physically fit students tend to maintain this advantage throughout the next four years of their academic careers. There are exceptions to these findings, however. Students who are unfit but successful academically are more likely to have more advantaged backgrounds, and physically fit students with low academic performance tend to have less advantaged backgrounds. Socio-economic factors appear to act as buffers in the fitness-achievement link.

Nearly a quarter of the students we observe either improve or decline in their fitness over the years we examine. Those who improved their fitness over time saw slight improvements in test scores compared to those whose fitness declined. Being consistently physically fit is more of an advantage in terms of academic outcomes than improving fitness over time.

There are a number of policy and programmatic implications for this work. Most importantly, we find that physical fitness differences affect students as early as fourth grade, pointing to a need for early intervention in students' physical fitness. This is especially the case for lower socio-economic status students, who are doubly disadvantaged in that lower SES is associated with both lower rates of passing the PFT and lower CST scores. Although schools do not assess physical fitness until fifth grade, our research shows that low-SES students are most likely to be physically unfit and that there is already a gap in test scores by fourth grade between

fit and unfit students, even after taking SES into account. Although we would not suggest that improving the health of unfit students will raise all their test scores, the evidence does suggest that interventions aimed at improving physical fitness, especially if implemented consistently over time, could be one of a number of strategies aimed at helping disadvantaged students succeed in school.

One clear way that schools and school districts can work with students to improve physical fitness is through state-mandated physical education programs. Some educators have expressed concern that more physical education will detract from students' academic learning, and a recent survey of school districts nationwide finds that 44% increased time allotted to math and ELA at the expense of other subjects, including physical education (McMurrer, 2008). However, studies have shown that students' academic outcomes do not suffer when more physical education is introduced in the school day (Carlson et al., 2008; Coe, Pivarnik, Womack, Reeves, & Malina, 2006) and that some students may actually benefit academically when physical education is more rigorous (Coe et al., 2006; Sallis et al., 1999). The California Education Code requires that schools provide students in grades one through six with 200 minutes of physical education for every ten school days, the equivalent of 20 minutes per day (California Education Code section 51210.(g)). Students in grades seven through 12 are mandated twice that level – 400 minutes for every 10 school days, the equivalent of 40 minutes per day (California Education Code 51222.(a)). It may be that counting minutes of physical education is less important than focusing on the extent to which students are engaged in physically beneficial activities during that time. This distinction is prominent in the new Physical Education Framework adopted by the California Department of Education (CDE) in 2008. The new framework emphasizes the importance of ensuring that all students have access to high-quality physical education programs and that these programs use instruction aligned to physical education standards to ensure that all students

master age-appropriate skills (California Department of Education, 2008). In addition, there is currently a bill in the California legislature (A.B. 2072) to establish a Physical Education Award Program that would recognize model physical education programs and those demonstrating increasing numbers of students passing the PFT. If passed, schools selected for this award would be recognized publicly through: classification as a distinguished school; being listed on a published public school honor roll; or public commendations by the Governor and the Legislature.

Physical education class is not the only place that students can learn about physical fitness and healthy eating habits at school. Recess time can also be used to focus in on student health. Indeed, the Robert Wood Johnson Foundation has just invested \$18 million in an initiative aimed at improving children's health through safe and healthy playtime at recess in low-income schools (Robert Wood Johnson Foundation, 2008). Additionally, health and nutrition or communications and media classes focused on a variety of topics, including media imaging around health and fitness, can have a positive effect on students' health outcomes, particularly for low-income youth (see the review in Kumanyika & Grier, 2006).

Schools have a number of other options to help students make healthy choices by focusing on the types of foods and drinks offered at the school in school meals, vending machines, and club fundraisers (Story, Kaphingst, & French, 2006). School gardens are another possible means to help youth learn about and directly take part in nutritious foods by growing and cooking them or donating them to the school cafeteria to be served at lunch. The CDE estimates that 3,000 of California's schools have a school garden (California Department of Education, 2007b), and the CDE offered a total of \$10.9 million in funding for these gardens in the 2006-07 school year (California Department of Education, 2007a).

Solutions to the problem of poor fitness also lie outside the school environment. County health departments, local public health agencies, and community-based organizations focused on youth, health, and well-being can collaborate with schools to reinforce the positive health message. Various city and county agencies are involved in the health of young people through the provision of sports and recreation activities, mental and physical health services, and food assistance. Involving parents in programs aimed at improving children's physical fitness is also critical, as parents who reinforce and model healthy behaviors are more likely to have children who follow their leads (see Kumanyika & Grier, 2006, for a review of this literature).

There are a number of ongoing efforts to improve physical health and nutrition in San Mateo County and statewide. For instance, the San Mateo County Department of Health is currently undertaking an effort to track food offerings in the North Fair Oaks community to better understand the locations of healthy and unhealthy food options in a disadvantaged area. There are also several current pieces of legislation related to fitness and nutrition. The State legislature is considering a bill (A.B. 2989) that would provide grants to education programs focused on high-risk populations who have poor access to outdoor recreation and educational experiences. The legislature is also considering options for more streamlined enrollment of schoolchildren into the National School Lunch and School Breakfast program by accessing their Medical records for proof of eligibility (A.B. 2300).⁴ California's menu labeling legislation (S.B. 1420), which requires chain restaurants in the state to provide nutritional information for all menu items, has just been signed by the Governor. The intent is to be transparent about nutritional content so that consumers can make informed decisions, a principle that could be applied in school settings as well. These efforts are all positive indicators of concern

⁴ Currently, only CalWORKs and Food Stamps receipt are considered for automatic enrollment into Free and Reduced Breakfast and Lunch programs.

about children's physical health and nutrition at a variety of governmental levels. Clearly, more collaborative work is needed to create healthier nutrition options for youth inside schools and in their communities to reduce the influences of unhealthy food choices and food establishments.

As we move forward with this work, the Youth Data Archive will consider the role of each of these types of activities and services to support partners in increasing positive outcomes in the health, well-being and student achievement of young people living in the Redwood City area.

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http://gardnercenter.stanford.edu/current_initiatives/youth_archive.html.