ABSTRACT

BACKGROUND: In 2009, the Pennsylvania Department of Health developed the *Active Schools Program* (ASP) which required 30-minutes of daily physical education (PE) in middle schools to reduce childhood obesity. This investigation evaluated the ASP effects on physical fitness and weight status in middle school adolescents throughout one academic year.

METHODS: A quasi-experimental design was used to recruit middle schools into an intervention group (N=30) or control group (N=9).

RESULTS: Physical fitness outcomes had larger intervention effects than weight status outcomes. These effects were most profound among at-risk students. Multiple linear regression analysis provided a best-guess effect of daily PE on BMI percentile of -1.2, 95% CI (-1.9, -0.5) for at-risk females and -0.8, 95% CI (-1.5, -0.1) for at-risk males. Much of this benefit is attributable to the differential increase in physical fitness achieved by students with the benefit of having daily PE.

CONCLUSIONS: Thirty-minutes of daily PE can be considered a scientific approach to ameliorate health outcomes in at-risk middle school adolescents, particularly among females. Improvements on BMI percentile among at-risk youth are presaged by greater improvements in physical fitness. This investigation supports a school-based approach aimed to improve behavioral risk factors as a means to reduce childhood obesity.

Keywords: physical education; in-school physical activity; fitness; obesity; youth

Sedentary lifestyles and physical inactivity in youth are among the myriad contributors of the childhood obesity epidemic.[1,2] Obese children and adolescents are more likely than their normal weight counterparts to become obese adults and suffer adverse health consequences prematurely.[3-5] Regular physical activity in youth reduces the risk for childhood and adolescent obesity and reduces the risk for developing costly, debilitating, and deadly obesity-related chronic disease.[6,7] Youth spend much of their day at school; hence, in-school physical activity programs provide the opportunity for students to acquire a substantial portion of recommended daily physical activity through PE programs and other physical activity opportunities integrated into the school day.[8,9]

The United States (U.S.) Department of Health and Human Services recommends youth age 6-17 years engage in a minimum 60-minutes of daily physical activity[10] and the Institute of Medicine recommends all students in Kindergarten through 12th grade be given adequate opportunity to engage in 60-minutes of in-school physical activity per day.[11] Particularly among middle school-age youth, the National Association for Sport and Physical Education recommends students engage in daily physical education (PE) that is equivalent to 225-minutes per week.[12] However, according to the *School Health Policies and Programs Study* (2006), 7.9% of U.S. middle schools provided daily PE or its equivalent (225-minutes per week) for the entire school year.[8] Limited exposure to in-school physical activity opportunities may encourage physical inactivity in youth, may promote lifestyle physical inactivity, and contributes to childhood obesity.

In 2009, the Pennsylvania Department of Health (PADoH) developed a one-year pilot program, the *Active Schools Program* (ASP), to explore the feasibility of requiring daily PE in Pennsylvania schools. Participating middle schools (6th through 8th grades) were required to

implement 30-minutes of daily PE as a means to increase regular physical activity and reduce the burden of childhood obesity. An evaluation of the ASP was conducted to determine the effects of 30-minutes of daily PE on weight status and physical fitness, and to make comparison to control schools (non-daily PE). This paper reports the outcomes of the ASP evaluation and makes contributions to what is known about the effects of daily PE on middle school youth physical fitness and weight status.

METHODS

Participants

A quasi-experimental design was used to determine the effects of daily PE on middle school students' (6^{th} through 8^{th} grades) physical fitness and weight status. Participants in this investigation included students from intervention (9,722 students) and control (4,881 students) middle schools spanning the Commonwealth of Pennsylvania. The intervention schools (N=30) were competitively selected to participate in the ASP in 2009 from among Pennsylvania school districts with obesity rates higher than the 2007-2008 statewide average (33.2%).[13] The control schools (N=9) were selected in 2010 using similar selection criteria to allow for a comparison of physical fitness and weight status outcomes between intervention and control groups. The sample used in subsequent analyses consisted of students with complete pre- and post-assessment data; including, 6,693 intervention school students (68.8% follow-up) and 3,513 control school students (71.9% follow-up).

Procedure

The intervention group was provided with funding through a Preventive Health and Human Services Block Grant from the Centers for Disease Control and Prevention (CDC) distributed by PADoH to purchase and implement an evidence-based PE program of their choice

from a list including HOPSports®, SPARK™, CATCH®, Project Fit America®, Physical Best, and HEALTHY PE or to propose and implement their own PE program, to implement 30-minutes of daily PE throughout one academic year (September 2009 through June 2010), and to conduct pre- and post-assessments during this time period (Fall 2009 and Spring 2010). The control group maintained their normal schedule of non-daily PE throughout one academic year (September 2010 through June 2011) and was provided with funding from *Active Living Research* (RWJF #68311) to conduct pre- and post-assessments during this time period (Fall 2010 and Spring 2011). The PE curricula were implemented by each respective school PE teacher.

Selected demographic characteristics were recorded and used for descriptive and analytic purposes, including each student's sex, age, and grade. Height and weight were measured by a school nurse using PADoH protocols.[14] Physical fitness was measured using three physical fitness tests, including, one-mile run, curl-ups, and push-ups. The mile run was a timed test. The curl-up test required students to perform as many curl-ups as possible in one minute. The push-up test required students to execute push-ups using proper form until failure. Height, weight, and physical fitness were assessed at the start (Fall) and end (Spring) of each respective academic year and the same assessment protocols were administered by both the intervention and control groups at the school-level. Teachers were trained to conduct each protocol and recorded data in an Excel file created by the CDC for use in schools.[15] This file calculated body mass index [BMI = (weight in pounds/height in inches^2)·703] and BMI percentile from height, weight, sex, and age. The file was modified to allow entry of physical fitness scores. Five outcome measures were examined; two weight status outcomes (change in BMI score and change in BMI percentile), and

three physical fitness outcomes (change in mile run time, change in push-ups, and change in curl-ups).

Data Analysis

The length of time between data collection points for the intervention and control groups varied across schools. The mean number of days between assessments at the control schools (206.8 days) was approximately one month shorter than at intervention schools (235.7 days). To control for potential differences in outcomes because of differences in the number of days between data collection points, we compared annualized versions of each change by multiplying the change by 365 and dividing by the number of days between assessments. All outcome measures are reported as an annualized change.

To examine changes within groups from pre- to post-assessment, a one-sample *t* test was performed on each outcome measure. All tests of statistical significance used p = .05 based on a two-tail test. Independent samples *t* tests were used to identify differences between the intervention and control groups on each outcome measure, and standardized mean difference (Cohen's d) and 95% confidence interval values were calculated using Lipsey and Wilson's effect size calculator to determine the overall effect size for each outcome measure.[16] Calculations for each outcome measure were conducted to represent a positive difference associated with the intervention group having superior performance compared to the control group. Samples were disaggregated to examine intervention effects by sex, and by sex × at-risk status [at-risk: overweight and obese ($\geq 85^{th}$ percentile for age and sex) for at least one of the assessments compared to not at-risk ($< 85^{th}$ percentile for age and sex) at both assessments].[17] A difference in proportions test was utilized to identify significant group differences.

Multiple linear regression analyses of change in BMI percentile were conducted on at-risk subsamples because there are health implications of change in BMI percentile that can be unambiguously delineated for these at-risk students. At-risk subsamples were examined separately for females and males and include all students categorized as overweight or obese at either pre- or post-assessment time points. Pre-assessment BMI percentile was included in cubic functional form in each regression model. Two regression models were applied to each subsample. Model I controlled for starting BMI percentile. Model II included changes in physical fitness covariates. Each model included a DailyPE dummy variable to provide a best guess estimate of the effect of daily PE on change in BMI percentile for at-risk individuals. All data were cleaned in Excel and IBM SPSS Statistics 20 was used for statistical analysis.

RESULTS

Participant Characteristics

The mean percentage of females in the intervention group was 49.3%, not significantly different from the 50.4% in the control group ($p = .29$). There were significantly ($p < .001$) fewer sixth grade intervention students (24.0%) than control students (31.9%) and significantly ($p < .001$) more eighth grade intervention students (35.5%) than control students (26.0%) but the portion of seventh grade intervention students (40.5%) was not significantly ($p = .11$) different from control students (42.2%). After controlling for grade differences, there were no significant differences in mean age between the intervention and control groups ($p = .67$, $p = .72$, and $p = .64$ for Grade 6, 7, and 8, respectively). The mean percentages of intervention students who were at-risk (37.7%) at pre-assessment were not significantly different from control students (37.0%) at pre-assessment ($p = .48$).

Physical Education Effects on Physical Fitness and Weight Status

Table 1 provides summary information for pre- and post-assessment performances. Table 2 provides annualized mean differences in these performances for each of the subsamples in Table 1. Table 2 shows that annualized change in BMI increased for all subsamples. The intervention group demonstrated significant improvement on BMI percentile, mile run, curl-ups, and push-ups while the control group demonstrated significant improvement on push-ups and curl-ups. Among at-risk students a similar pattern was observed; at-risk females and males in the intervention group demonstrated significant improvement on BMI percentile, mile run, curl-ups, and push-ups while their control counterparts only demonstrated significant improvement on push-ups for females and push-up and curl-ups for males.

[Insert Tables 1 and 2. here]

The results of the independent samples *t* tests on difference between intervention and control means are most effectively presented using standardized mean difference (SMD; a measure of effect size), which revealed significant improvements for the intervention group relative to the control group on four of the five overall sample outcome measures (Figure 1). Effect sizes demonstrated that 30-minutes of daily PE has a similar effect on mile run and curl-up performances with SMDs in the range of 0.3 to 0.4 (medium effect size) for 12 of 14 comparisons in Figure 1. The weakest outcome effect was change in BMI percentile, which was not significant in the full sample ($p = .06$), but was significant in the female subsample ($p < .05$) and at-risk female subsample ($p < .05$). In each subsample, females obtained greater benefit of daily PE for curl-ups while males obtained greater benefit for mile run. The effect size of 30-minutes of daily PE on push-ups was small but significant, most notably among the at-risk subsamples.

Among weight status outcomes in Figure 1, the intervention was most effective for at-risk students and the largest effect (modest) was observed for change in BMI among at-risk males [SMD = 0.19; 95% CI (0.10, 0.28)]. Among the at-risk subsamples, change in BMI percentile for males was the only outcome (out of ten) that was not significant ($p = .06$). By contrast, five of ten outcomes among the not at-risk subsamples were not significant, including all weight status outcomes. Examination by sex revealed two of ten outcomes were not significant, push-ups for females and BMI percentile for males.

[Insert Figure 1. here]

Regression Analyses of Change in BMI Percentile for At-Risk Students

The results of four regression analyses are described in Table 3. Comparison of both models for each subsample demonstrated that a positive change in physical fitness was predictive of decreased BMI percentile. The change in adjusted R^2 when considering the changes in physical fitness variables ranged from 1.0% (female) to 1.4% (male). Change in push-up and mile run performances were significant predictors in both models but change in curl-up performance was not significant in the female model. The Daily PE Net Effect for females (-1.2) and for males (-0.8) provides a best guess of the influence 30-minutes of daily PE had on the BMI percentile of at-risk students. A comparison of the DailyPE dummy variables in Models I and II showed that much of this benefit was due to the differential increase in physical fitness achieved by students with the benefit of having daily PE. This is especially noticeable for males where the DailyPE dummy decreased in magnitude by more than 70% (from -1.05 to -0.28) and was not statistically significant upon inclusion of physical fitness covariates ($p = .55$). By contrast, the female DailyPE dummy declined by only 25% (from -1.61 to -1.20) and remained statistically significant upon inclusion of physical fitness covariates ($p < .01$). Comparison of the

relative sizes of the change in physical fitness slope coefficients suggest that females obtained greater benefit from improved push-up performance than males, and males obtained greater benefit from improved mile run and curl-up performances than females.

[Insert Table 3. here]

DISCUSSION

The ASP intervention, which required 30-minutes of daily PE for Pennsylvania middle school students, had the greatest effects on physical fitness outcomes and is consistent with scientifically established acute and chronic physiological outcomes of regular physical activity on physical fitness in youth.[2] There is evidence to suggest school PE practices are strong predictors of physical fitness, including cardiovascular and muscular fitness.[2,18] Thus, the improvements experienced by the intervention group on cardiovascular (mile run) and muscular fitness (push-ups and curl-ups) could be the result of exposure to 30-minutes of daily PE throughout one academic year. This finding is noteworthy because evidence suggests that regular physical activity and increased levels of physical fitness attenuate the adverse health consequences of overweight and obesity,[19] yield health benefits in at-risk youth,[19] and may be linked to reductions in total body and visceral adiposity in adolescents.[2] Hence, provision of daily PE in middle schools can be considered one of the many required population approaches to improve adolescent health through improved physical fitness.

The effects of 30-minutes of daily PE on weight status outcomes were less profound than those observed on physical fitness, however, are nonetheless meaningful and noteworthy. Statistically significant increases in mean BMI scores were observed within the intervention and control groups and this finding is consistent with a recent meta-analysis that examined the effects of school-based physical activity interventions on changes in BMI score and found no significant

improvement.[20] It is important to consider three physiological phenomena when interpreting intervention effects on BMI score. First, changes in height and weight in youth occur inconsistently, most notably during pubescence, and vary by sex and age, and the amount of body fat in youth changes with age and differs between males and females. Hence, the CDC recommends the use of BMI growth charts that are sex and age specific to categorize BMI scores in youth (2 through 20 years) as healthy or unhealthy.[17] Second, the CDC BMI growth charts demonstrate an upward slope during adolescence, which reflects aging in each respective sex and necessitates a relative increase in BMI over time to account for normal growth and development in youth.[17] Third, it is important to consider physical activity in relation to the copious demands of adolescence associated with growth, maturation, and behavioral development.[2] Thus, much of the significant increases in mean BMI scores observed in the current investigation are likely a function of the normal growth, maturation, and behavioral development in adolescence and may not reflect an increase in weight-related health risk. The authors caution the use of BMI score as a solitary or primary outcome measure when evaluating in-school physical activity interventions and recommend the use of BMI percentile derived from the CDC BMI growth charts to examine the effects of behavioral interventions on downstream and chronic health outcomes (obesity) in youth, particularly when examining these effects in overweight and obese populations.

Overweight and obese adolescents are at greater risk than their normal (healthy) weight counterparts for developing obesity-related chronic disease and suffering from associated myriad adverse consequences early in life.[11,21] Thus, there are substantial health implications of positive or negative changes in BMI percentile that can be unambiguously delineated for at-risk adolescents. The CDC uses BMI percentiles to categorize youth into weight-related health risk (underweight, overweight, and obese) or non-risk (normal weight) categories based on BMI, age,

and sex.[17] Examining changes in BMI percentile is reflective of changes in weight-related health risk because BMI percentile accounts for the growth and maturation in youth that is not demonstrable when examining BMI score alone. The overweight and obese students exposed to 30-minutes of daily PE significantly improved BMI percentile relative to those not exposed to daily PE. There is notable public health relevance in this finding in support of a school-based policy and population approach to improve weight status and reduce health risk in overweight and obese middle school adolescents by way of 30-minutes of daily PE and improved physical fitness.

A primary purpose of school-based physical activity and nutrition programs are to reduce and prevent obesity in youth. Strategies to ameliorate adolescent obesity require confronting upstream behavioral risk factors which are critical to obesity etiology, namely, physical activity. Regular physical activity improves physical fitness, reduces the risk for excessive weight gain, and improves overall health and wellbeing.[22] The overweight and obese intervention students in this investigation demonstrated significant physical fitness improvements compared to their control counterparts, and the improvements in physical fitness presaged improvements in BMI percentile, most notably in overweight and obese females. There are critical public health implications in these findings which support school-based strategies that promote daily PE as a means to improve physical fitness and subsequently, improve weight status in overweight and obese students. Furthermore, among adolescents, males typically engage in greater amounts of physical activity than females[23] and evidence suggests that males and females do not respond comparably to a given intervention.[24] This investigation demonstrated that male and female middle school adolescents were impacted differently by the provision of 30-minutes of daily PE and infer that required daily PE may be most beneficial for overweight and obese female

adolescents, which further substantiates previous recommendations to raise PE credit requirements as a means to increase overall physical activity among females.[25]

Limitations

The outcomes of this investigation contribute to a growing body of scientific literature to support daily PE as one approach among a required many needed to combat childhood obesity. However, the contributions of this investigation are not without limitation. First, although each ASP school agreed to implement 30-minutes of daily PE, compliance to this regimen was not monitored and thus program fidelity is unknown. Understanding in-school physical activity policy and program implementation practices is critical to evaluating the effects of school-based physical activity policy because previous investigations demonstrate schools have policies that support physical activity but unfavorable implementation practices exist.[26] Hence, program implementation practices and program fidelity are important constructs to understanding program effectiveness and replication, particularly for costly programs.

A second limitation is that the percent of PE class time spent in moderate-to-vigorous physical activity (MVPA) was not assessed. National recommendations suggest students spend 50% of PE class time in MVPA[10] and the majority of the recommended 60-minutes of daily physical activity for youth are encouraged to be spent in MVPA.[27] The purpose of this investigation was to evaluate the effects of 30-minutes of daily PE on middle school adolescents physical fitness and weight status and was not aimed at evaluating the effects of national physical activity recommendations for youth. Nonetheless, future investigations are needed to examine the amount of time youth spend in MVPA when given the opportunity for 30-minutes of daily PE in order to better understand the influence such policy has on youth meeting recommended duration and intensity of physical activity.

Third, student's out-of-school physical activity was not assessed and investigators are unaware of the out-of-school physical activity opportunities afforded to youth through their respective home and community environments that may influence adolescents' engagement in physical activity. Incorporating a comprehensive community approach to understanding physical activity patterns and reducing obesity in youth broadens previous recommendations that address health behaviors supported or deterred within a child's home environment.[24] An ecological approach to public health, particularly childhood obesity, suggests future investigations seek to understand students' engagement in out-of school physical activity in tandem with in-school physical activity.[28] The importance of utilizing an ecological framework is two-fold. First, with competing academic priorities and monetary barriers, the expectation that schools are responsible for providing youth with the full amount of recommended daily physical activity remains in question and may be most salient among schools that serve low-income communities where environmental and health disparities are prevalent. For the middle school adolescents exposed to daily PE in this investigation, it appears that 30-minutes of PE were sufficient to improve physical fitness and curb obesity. Second, these data do not control for the influence of out-of school physical activity. Understanding the opportunities for physical activity within the broader community may clarify the role of schools in aiding youth to meet daily recommendations and guide future in-school physical activity policy at the local level.

A final limitation of this investigation is that school nutrition policies and students' dietary behaviors were not examined, thus the influences of these factors are unknown. There is evidence to suggest combination nutrition and physical activity interventions in the school setting are effective at achieving weight reduction, as measured by total body weight [SMD = -0.29; 95% CI (-0.45. -0.14)].[29] Obesity is largely fueled by energy intake and output

imbalance[2,30]; therefore, it is recommended that future ecological-based investigations consider both dietary and physical activity perspectives characteristic of the school setting and include consideration of the home and surrounding local environments. At a macro-level, statewide policies provide impetus for local-level action as demonstrated by the ASP, and may provide much of the impetus for communities to examine and adopt ecological approaches to improve community health and wellness.

Conclusions

In 2009, the PADoH developed the ASP which required 30-minutes of daily PE for middle school students (6th through 8th grades) throughout one academic year as a means to increase regular physical activity and reduce the burden of childhood obesity. The ASP intervention demonstrated significant improvements in physical fitness and weight status among overweight and obese Pennsylvania middle school students. From a school health perspective, this investigation supports integrating 30-minutes of daily PE into middle school adolescents' school day as a population approach to improve health behaviors and reduce childhood obesity through regular physical activity. The opportunity for daily PE may afford seminal behavioral effects that foster lifestyle physical activity[18] and conveys a critical public health message for youth, there is time for daily physical activity, and taking time to be active is important to one's health, overall wellbeing, and daily function.[22]

IMPLICATIONS FOR SCHOOL HEALTH

School health strategies are a critical component of multidisciplinary and population approaches that are needed to combat the childhood obesity epidemic. The physical fitness and weight status improvements demonstrated by the ASP intervention students provide further support for the inclusion of daily PE for middle school students recommended by the National

Association for Sport and Physical Education.[31] Importantly, the greatest improved outcomes were observed among overweight and obese students, which supports a population approach to improve physical fitness and health outcomes in high risk youth, as opposed to costly individualized or small group approaches. Regular in-school physical activity also provides academic and behavioral benefits that are congruent with the priorities of school administrators and educators; students that are more active at school and more physically fit are higher academic performers,[32] report less absenteeism,[33] and have less behavior-related truancy[33] than students that are less active at school. Furthermore, there is consistent evidence that time devoted to PE and other in-school physical activity does not hinder academic performance.[32] In summary; middle schools are encouraged to incorporate 30-minutes of daily PE into students' school day as a means to improve adolescent physical fitness, reduce obesity in at-risk students, and prepare students to be optimal learners.

HUMAN SUBJECT APPROVAL

All procedures were approved by the Dickinson College Institutional Review Board.

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Table 1. **Weight Status and Physical Fitness for Two Assessments Disaggregated by Sex × At-risk Status**[a]

Subsample (N)			Assessment	Weight status		Physical fitness		
				BMI	BMI percentile	Mile run	Push-ups	Curl-ups
Overall sample (10206)			Fall	21.7 (5.0)	66.8 (28.7)	11.2 (3.2)	14.1 (11.7)	35.2 (13.9)
			Spring	22.0 (5.0)	66.1 (28.4)	10.7 (3.0)	17.2 (13.4)	39.8 (15.0)
DailyPE (6693)			Fall	21.7 (5.0)	67.0 (28.6)	11.5 (3.3)	14.1 (11.8)	35.2 (14.0)
			Spring	22.0 (5.0)	66.2 (28.2)	10.7 (3.1)	17.5 (13.6)	41.6 (15.8)
Control (3513)			Fall	21.5 (4.9)	66.4 (28.9)	10.6 (2.7)	14.2 (11.7)	35.3 (13.9)
			Spring	21.9 (5.0)	66.0 (28.9)	10.6 (2.9)	16.5 (13.0)	36.5 (12.7)
Female	DailyPE (3296)		Fall	21.9 (5.0)	67.6 (27.8)	12.2 (3.3)	10.0 (9.2)	32.3 (13.0)
			Spring	22.3 (5.0)	67.3 (27.0)	11.5 (3.1)	12.6 (10.8)	37.9 (14.6)
	Control (1769)		Fall	21.8 (5.1)	66.4 (28.9)	11.3 (2.6)	10.9 (9.6)	32.7 (12.4)
			Spring	22.2 (5.1)	66.8 (28.2)	11.2 (2.8)	13.0 (11.5)	33.6 (11.6)
Male	DailyPE (3397)		Fall	21.5 (4.9)	66.4 (29.3)	10.9 (3.3)	18.0 (12.6)	38.1 (14.3)
			Spring	21.7 (4.9)	65.1 (29.3)	10.0 (3.0)	22.2 (14.4)	45.2 (16.1)
	Control (1744)		Fall	21.3 (4.7)	66.3 (28.8)	10.0 (2.6)	17.5 (12.6)	37.8 (14.8)
			Spring	21.6 (4.9)	65.1 (29.5)	10.0 (2.9)	20.2 (13.4)	39.4 (13.2)
Not at-risk	Female	DailyPE (1940)	Fall	18.7 (2.0)	50.2 (23.4)	11.4 (3.1)	11.9 (9.8)	34.4 (12.8)
			Spring	19.2 (1.9)	50.5 (22.5)	10.6 (2.8)	14.6 (11.5)	40.2 (14.3)
		Control (1046)	Fall	18.5 (2.1)	48.4 (24.2)	10.4 (2.4)	12.9 (10.0)	35.2 (12.8)
			Spring	18.9 (2.1)	49.2 (23.5)	10.3 (2.5)	15.4 (12.3)	36.4 (11.5)
	Male	DailyPE (1996)	Fall	18.3 (1.8)	47.6 (23.7)	10.0 (2.8)	21.3 (12.9)	40.3 (14.1)
			Spring	18.6 (1.8)	46.2 (23.3)	9.1 (2.4)	25.7 (14.5)	47.6 (16.1)
		Control (1037)	Fall	18.3 (1.8)	48.1 (23.4)	9.1 (2.2)	21.0 (12.9)	39.8 (14.1)
			Spring	18.5 (1.9)	46.5 (23.8)	9.0 (2.4)	23.8 (13.7)	41.7 (12.7)
At-risk	Female	DailyPE (1356)	Fall	26.5 (4.5)	92.4 (7.0)	13.3 (3.2)	7.4 (7.5)	29.3 (12.8)
			Spring	26.7 (4.7)	91.2 (8.4)	12.7 (3.0)	9.6 (8.9)	34.7 (14.4)
		Control (723)	Fall	26.4 (4.4)	92.5 (6.7)	12.5 (2.4)	8.1 (8.2)	29.2 (10.8)
			Spring	26.9 (4.5)	92.3 (6.9)	12.6 (2.6)	9.4 (9.2)	29.7 (10.5)
	Male	DailyPE (1401)	Fall	26.0 (4.3)	93.2 (7.1)	12.3 (3.4)	13.4 (10.4)	34.9 (14.0)
			Spring	26.1 (4.4)	92.0 (8.1)	11.4 (3.2)	17.3 (12.7)	41.7 (15.6)
		Control (707)	Fall	25.8 (4.2)	92.9 (7.2)	11.3 (2.7)	12.5 (10.3)	34.8 (15.3)
			Spring	26.2 (4.4)	92.5 (7.7)	11.4 (2.9)	14.8 (11.1)	36.2 (13.2)

Abbreviations: DailyPE, Active Schools Program. BMI, body mass index.

[a]Values are expressed as mean (SD) unless otherwise indicated. At-risk students had BMI percentile ≥ 85 in the fall or spring assessment.

Table 2. **Annualized Mean Differences Disaggregated by Sex × At-risk Status**

Subsample (N)			Annualized Mean Difference for Five Outcome Measures by Subsample[a]				
			Weight status		Physical fitness		
			BMI	BMI percentile	Mile run	Push-ups	Curl-ups
Overall sample (10206)			0.53 (2.5) (0.48, 0.58)	-1.02 (17.9) (-1.37, -0.67)	-0.82 (3.9) (-0.9, -0.75)	4.97 (14.8) (4.68, 5.25)	7.15 (22.6) (6.71, 7.59)
DailyPE (6693)			0.45 (2.4) (0.39, 0.51)	-1.26 (17.6) (-1.68, -0.84)	-1.25 (3.8) (-1.34, -1.15)	5.32 (13.8) (4.99, 5.65)	9.83 (22.3) (9.29, 10.36)
Control (3513)			0.68 (2.6) (0.59, 0.76)	-0.56 (18.6) (-1.17, 0.06)	-0.01 (3.9) (-0.14, 0.12)	4.3 (16.5) (3.75, 4.85)	2.05 (22.3) (1.31, 2.79)
Female	DailyPE (3,296)		0.53 (2.4) (0.45, 0.61)	-0.49 (17.1) (-1.07, 0.1)	-1.12 (3.9) (-1.25, -0.98)	4.03 (11.5) (3.64, 4.43)	8.64 (20.3) (7.94, 9.33)
	Control (1769)		0.75 (2.6) (0.63, 0.87)	0.79 (17.2) (-0.01, 1.6)	-0.03 (4.0) (-0.22, 0.15)	3.73 (16.2) (2.97, 4.49)	1.44 (20.1) (0.51, 2.38)
Male	DailyPE (3397)		0.37 (2.3) (0.29, 0.45)	-2.01 (18.0) (-2.61, -1.4)	-1.37 (3.6) (-1.49, -1.25)	6.56 (15.6) (6.04, 7.09)	10.98 (23.9) (10.17, 11.78)
	Control (1744)		0.60 (2.6) (0.48, 0.72)	-1.93 (19.8) (-2.86, -1)	0.01 (3.9) (-0.17, 0.19)	4.88 (16.8) (4.09, 5.66)	2.67 (24.3) (1.52, 3.81)
Not at-risk	Female	DailyPE (1940)	0.65 (1.7) (0.57, 0.72)	0.41 (19.6) (-0.46, 1.29)	-1.26 (3.8) (-1.43, -1.09)	4.34 (12.0) (3.8, 4.87)	9.00 (20.4) (8.1, 9.91)
		Control (1046)	0.74 (1.7) (0.64, 0.84)	1.64 (20.1) (0.42, 2.86)	-0.12 (3.8) (-0.35, 0.11)	4.63 (18.0) (3.54, 5.72)	1.98 (21.2) (0.69, 3.27)
	Male	DailyPE (1996)	0.51 (1.6) (0.44, 0.57)	-2.11 (20.9) (-3.03, -1.2)	-1.4 (3.4) (-1.55, -1.25)	6.84 (16.8) (6.1, 7.58)	11.38 (24.5) (10.31, 12.46)
		Control (1037)	0.45 (1.7) (0.35, 0.55)	-2.76 (23.0) (-4.16, -1.35)	-0.1 (3.7) (-0.33, 0.12)	5.30 (18.0) (4.2, 6.4)	2.86 (25.0) (1.34, 4.39)
At-risk	Female	DailyPE (1356)	0.37 (3.2) (0.19, 0.54)	-1.78 (12.6) (-2.45, -1.11)	-0.91 (4.1) (-1.13, -0.7)	3.60 (10.6) (3.04, 4.17)	8.12 (20.3) (7.04, 9.2)
		Control (723)	0.77 (3.6) (0.51, 1.03)	-0.43 (11.8) (-1.29, 0.43)	0.10 (4.2) (-0.21, 0.4)	2.42 (13.2) (1.46, 3.39)	0.67 (18.3) (-0.67, 2)
	Male	DailyPE (1401)	0.18 (3.1) (0.02, 0.35)	-1.86 (12.8) (-2.53, -1.19)	-1.33 (3.9) (-1.54, -1.13)	6.17 (13.7) (5.45, 6.88)	10.40 (23.1) (9.19, 11.61)
		Control (707)	0.82 (3.4) (0.57, 1.08)	-0.72 (13.7) (-1.73, 0.3)	0.18 (4.3) (-0.14, 0.49)	4.26 (14.8) (3.17, 5.35)	2.37 (23.3) (0.65, 4.1)

Abbreviations: DailyPE, Active Schools Program. BMI, body mass index.

[a]Annualized difference = (Spring outcome - Fall outcome)·365/dDays where dDays = Spring date of measurement - Fall date of measurement. Values for each subsample are expressed in two rows with mean (SD) above and (95% confidence interval) below. At-risk students had BMI percentile ≥ 85 in the fall or spring assessment.

Table 3. **Regression Analysis of Annualized Change in Body Mass Index Percentile for At-risk Students by Sex**[a]

		Female (N = 2079)		Male (N = 2108)	
Variable	**Model:**	**I**	**II**	**I**	**II**
Intercept		-75.4 **	-67.3 **	-29.5	-22.7
		(26.1)	(25.9)	(20.9)	(20.8)
B% Fall		10.37 ***	9.97 ***	8.73 ***	8.32 ***
		(1.15)	(1.15)	(1.00)	(0.99)
B% Fall^2/10		-1.99 ***	-1.93 ***	-1.80 ***	-1.73 ***
		(0.16)	(0.16)	(0.15)	(0.15)
B% Fall^3/1000		1.03 ***	1.00 ***	0.96 ***	0.92 ***
		(0.07)	(0.07)	(0.07)	(0.07)
Δ in PF/Yr, dPF	Mile run		0.20 ***		0.30 ***
			(0.05)		(0.05)
	Push-ups		-0.08 ***		-0.04 **
			(0.02)		(0.02)
	Curl-ups		-0.02		-0.03 **
			(0.01)		(0.01)
DailyPE		-1.61 ***	-1.20 **	-1.05 *	-0.28
		(0.45)	(0.46)	(0.47)	(0.47)
Adjusted R^2		.362	.372	.410	.424
F		295 ***	177 ***	367 ***	222 ***
Daily PE Net Effect[b]		-1.2 (-1.9, -0.5)		-0.8 (-1.5, -0.1)	

Abbreviations: B%, body mass index percentile, DailyPE, Active Schools Program (daily physical education) dummy variable.

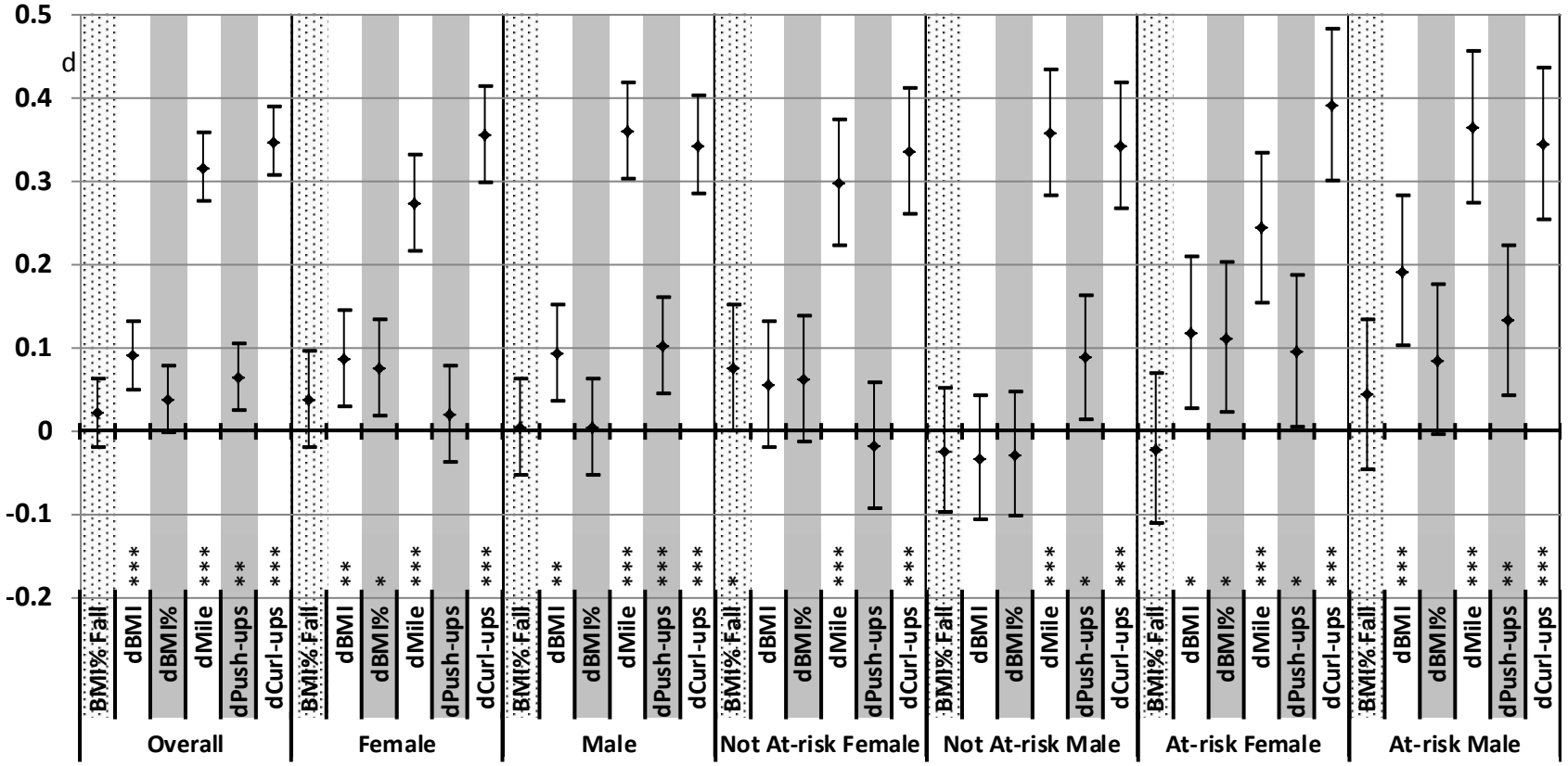
[a]The dependent variable is change in B% per year. Raw regression coefficients (SE) and *s denote statistical significance: "*" = p < .05, "**" = p < .01, "***" = p < .001. All subsamples restricted to students who had B% ≥ 85 in the fall or spring assessment. Model I controls for B% Fall and Model II includes annualized change in physical fitness (dPF) covariates.

[b]DailyPE Net Effect is expected change in BMI percentile per academic year (9 months or 0.75 year) controlling for dPF mean differences from Table 2 as appropriate. For example, the male DailyPE Net Effect of -0.8 = -1.05·0.75 in Model I and in Model II is calculated using the DailyPE and dPF coefficients from Model II, and the at-risk male dPF mean outcomes from Table 2 as:

-0.8 = 0.75·[-0.28 + 0.30·(-1.33 - 0.18) - 0.04·(6.17 - 4.26) - 0.03·(10.40 - 2.37)].

The 95% confidence interval for Daily PE Net Effect is calculated using Model 1.

Figure 1. **Effect Size of Daily Physical Education for Two Weight Status and Three Physical Fitness Outcomes and Fall BMI Percentile Standardized Mean Difference Disaggregated by Sex × At-risk Status**



Abbreviations: BMI, body mass index. d preceeding each outcome label denotes difference. Effect size (Cohen's d) is measured using standardized mean difference, SMD, calculated as SMD = (mean difference)/(total SD) using annualized outcome mean differences and total SD from Table 2. An SMD > 0 means higher performance by intervention than control for that variable. Fall BMI percentile mean difference, BMI% Fall, calculated as intervention – control from Table 1. Whiskers denote 95% confidence interval on d. Significant differences are noted with "*" = p < .05, "**" = p < .01, "***" = p < .001 next to SMD label. At-risk students had a BMI percentile ≥ 85 in the fall or spring assessment.