Research Article

# Aerobic Fitness Thresholds Associated with Fifth Grade Academic Achievement

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**ABSTRACT**

***Background:*** *Whereas effects of physical fitness and physical activity on cognitive function have been documented, little is known about how they are related.* ***Purpose:*** *This study assessed student aerobic fitness measured by FITNESSGRAM Mile times and/or Pacer circuits and whether the nature of the association between aerobic fitness and standardized academic performance is dose-response or threshold related.* ***Methods:*** *Standardized academic test scores and aerobic capacity scores were collected from two cohorts of 5th grade students over two years. The Mile run and Pacer circuits results were compared to patterns in students' academic test scores.* ***Results:*** *Sectioning of Mile times and Pacer circuits revealed a sharp peak in academic performance for boys who completed the Mile in 9 minutes or less. Girls' Pacer revealed peaks in academic performance at 12 and 30 circuits.* ***Discussion:*** *Results demonstrate that select achievements in the Mile or Pacer account for significant increases in academic performance on standardized tests.* ***Translation to Health Education Practice:*** *This study identifies aerobic fitness points which, if achieved, offer the greatest probability of increased academic success in fifth graders. Physical education, cross-curricular thematic units, and club activities can be portals of opportunity to increase moderate to vigorous physical activity and fitness in students. Furthermore, school-based physical activity and fitness opportunities may positively impact health risk factors associated with childhood obesity. Policies that increase aerobic activity opportunities in the school setting may increase overall academic performance, encourage positive health habits and improve immediate and future overall health.*

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## BACKGROUND

Daily physical education enrollment rates declined in the early 1990s and have not improved since that time. Only 35% of high school students report meeting nationally recommended levels of physical activity.[1] The effects of limited physical education, limited physical fitness and limited activity opportunities on executive function and academic achievement have been documented by a variety of authors.[2-7] Wittberg and colleagues found a strong association between aerobic fitness and academic achievement in West Virginia fifth graders. In their study, when all FITNESSGRAM measures were used in a full factorial ANOVA with body mass index (BMI), gender and meal program (a proxy for socio-economic status) as covariates, aerobic capacity was found to be the only fitness variable consistently appearing as important. It was always significant as a main effect variable while no other main effect variable achieved significance for any WESTEST subject. Two-, three-, and four-way interactions always included aerobic fitness and no other fitness measure was universal in these interactions.[8] Davis and colleagues documented evidence for a dose-response to regular, vigorous activity on executive function.[9] Similarly, Coe and colleagues demonstrated that higher grades were associated with vigorous activity, es-

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pecially levels meeting *Healthy People 2010* guidelines.[10] Furthermore, time away from the classroom desk does not appear to interfere with academic achievement.[10-12]

## PURPOSE

Previous research suggests that improving students' fitness levels through regular, vigorous activity improves academic achievement. At the same time, these activities reduce obesity risks and associated health disparities.[13] Whereas an association between students' fitness and academic performance has been established, little is known about the nature of this relationship. For instance, studies have highlighted the role of aerobic fitness in increasing cognitive performance.[2,3,6,8,9] Yet, we do not fully understand the best way to help students achieve aerobic fitness. Furthermore, we do not know if the best practice for achieving enough fitness to witness elevations in academic performance is the same for boys and girls. Accordingly, one objective of this study was to assess student aerobic fitness information as measured by Mile time and number of Pacer circuits using FITNESSGRAM.[14] The second objective was to explore whether the nature of the association between students' aerobic fitness and academic performance is based on a threshold or a dose-response schedule.

## METHODS

### *Subject Selection/Data Collection*

Participants were 5th grade students from one county school district in a relatively rural, primarily Caucasian area of West Virginia. Over two school years, 2006-2007 and 2007-2008, a total of 1941 students (50.9% male) ranging from 9-13 years participated in this study through passive school-based consent. West Virginia standardized academic test scores (WESTEST) and aerobic capacity, as measured by FITNESSGRAM, were collected on each child.

### *Measures*

*Academic achievement.* WESTEST is completed by West Virginia children in grades 3 through 8 plus grade 10. It is a criterion-based reference for academic performance used to identify areas in need of additional instruction and conducted in the Spring of the academic year. WESTEST scores four areas of academic performance: reading/language arts, mathematics, science, and social studies. A student is given one of five possible classifications on each area: (1) novice, (2) partial mastery, (3) mastery, (4) above mastery, and (5) distinguished. An acceptable range of mastery in a given subject is considered to be a score $\geq 3$.

*Fitness achievement.* FITNESSGRAM is used in West Virginia in grades 4-8 plus one high school year to assess a child's fitness in six areas: aerobic capacity, abdominal strength and endurance, body composition, upper body strength and endurance, flexibility and trunk extensor strength and flexibility. Performance on these individual scales is categorized into one of two groups. Children are either scored in the "healthy fitness zone" where students meet or exceed the fitness target, or "needs improvement zone," where the student fails to meet the fitness target.

For this study, actual scores were collected for each child's FITNESSGRAM aerobic capacity test instead of the dichotomous "healthy zone/needs improvement zone." Aerobic capacity was measured one of two ways: The Mile run or the Pacer. The Mile run was the time it took for the child to run or walk one mile. With the Pacer test, the student is expected to run back and forth across a 20-meter space at a pace defined on a beep-only or music audiotape and which gets faster each minute. If the student gets to the other side before the pacing beep, he or she must wait until the beep to run back. The student is stopped when he/she does not reach the line the second time before the beep. The score for the pacer was the number of circuits the child was able to complete. The Physical Education instructor made the decision on which aerobic fitness test to administer. FITNESSGRAM is also conduced near the end of the school year.

*Data analysis.* The West Virginia Department of Education Office of Technology and Information Systems designed a database of student variables from a web-based application (including BMI health screening and FITNESSGRAM results) and the West Virginia Education Information System (academic achievement test scores). Aerobic fitness scores were then added. All descriptors were removed such as school identification number, student identification number and student birth date prior to statistical analysis. Study procedures were implemented at the county level and approved by the County Superintendent of Schools and West Virginia University Internal Review Board.

Aerobic capacity data was sectioned so that faster children were compared to slower children using independent sample t-tests. This sectioning was done to examine whether academic differences peaked at specific aerobic fitness points, which could be evidence of fitness thresholds. Mile run times were sectioned every 20 seconds while Pacer data was sectioned every two circuits. Sectioning at these intervals was chosen to strike a balance between describing the pattern in t-statistics and minimizing the chance for Type II errors. Beginning and ending points of the sectioning were determined by keeping the smaller group at close to 10% of the sample population. Cohen's D effect-sizes were calculated to evaluate the strength of the significant findings in the t-statistic based on the given sample.[15] Cohen's D is calculated using the formula $d=(M_1-M_2)/s$ where d is the difference between the means, $M_1$ and $M_2$, divided by the standard deviation. Effects of .2 are defined as small effects, .5 are medium, and .8 are considered large effects. To explore whether the relationship between academics and aerobic fitness was based on a dose-response schedule, correlations of the different aerobic fitness tests with the four WESTEST subjects were examined. Finally, the correlation of the Mile run with Pacer circuits was examined to look for the strength of their association and to look for gender differences. Because FITNESSGRAM uses different standards for boys and girls, genders were kept separate for all analyses and gender differences were examined for all tests. All analyses were conducted using SPSS 17.0; inferences were

made from findings based on significance levels ≤ 0.01.

## RESULTS

### *Sample characteristics and aerobic fitness measures*

For the two school years, 471 students did the Mile run (241 boys, 230 girls); 1383 students performed the Pacer (694 boys, 689 girls). There were 114 students who completed both the Pacer and the Mile run. Overall, 201 students did not complete one or more of the WESTEST achievement tests or did not complete the aerobic fitness test, reducing the 1941 original sample to 1740 students who had all necessary information. The correlation of Pacer with Mile run for the 53 boys who took both was -0.671 ($P$<0.001 level). The correlation of Pacer with Mile run for the 61 girls who took both was -0.655 ($P$< 0.001 level).

Correlations of the various aerobic fitness tests with WESTEST scores are listed in Table 3. The boys' Mile average was correlated with each WESTEST score ($P$< 0.01 to $P$< 0.001) but the boys' Pacer was not related to any academic score. Conversely, girls Pacer circuits average was associated with all standardized scores ($P$< 0.01 to $P$< 0.001) but the girls' Mile average was not related to any academic score.

### *Associations between student aerobic fitness and academic performance*

The mean comparisons for the Mile run and the Pacer tests are listed in Tables 1 and 2 respectively. The mean WESTEST scores for boys able to run a 540 second (9-minute) mile and those who could not is listed in Table 4. Girls' mean WESTEST scores at 12 circuits and 30 circuits are also presented in Table 4.

## DISCUSSION

This study provides further evidence of an association between aerobic fitness and academic achievement in children. There were highly significant correlations with small to medium effect sizes for both girls' Pacer and boys' Mile run with all WESTEST subjects (Table 3). There were also areas in the sectioned mean comparison data (Tables 1 and 2) for girls' Pacer and boys' Mile run demonstrating highly significant differences in WESTEST scores between children able to achieve the number of circuits or time and those who could not. Figures 1 and 2 show the peaks found in the mean comparisons. Overall, these findings are supported by the medium effect sizes for the boys' Mile. The pacer results, however, had small effect sizes and should be interpreted with caution.

Correlations between boys' Mile time and WESTEST subjects are all significant as are the girls' Pacer circuits with WESTEST subjects. There is a very identifiable peak in the mean comparison data within the boys' Mile. This could be argued as evidence of a fitness threshold. If a boy can run a mile in 9 minutes (540 seconds), he may see an academic benefit. The mean WESTEST scores at that point for boys who were able to run a 540 second (9-minute) mile and those who could not is listed in Table 4. The girls' Pacer test is not as clear-cut: there does not appear to be a consistent pattern in the mean comparisons with increase in circuits. There appears to be two peaks with girls' Pacer comparisons: a sharp peak at 12 circuits and a broader peak beginning around 30 circuits (Table 4). Because of this inconsistency, both a dose-response pattern and a threshold pattern could be argued. More work separating genders to identify and confirm these aerobic capacity thresholds is needed before a definite intervention is developed.

It is intriguing that there appears to be a gender difference for the specific aerobic fitness test that is associated with academic achievement. While there may be the beginnings of a performance peak for the girls' Mile at 630 seconds, it is only strong for Reading. There appears to be no association between boys' Pacer and academic achievement. These results are surprising given the high correlation between the Pacer and the Mile for boys (-0.671) and girls (-0.655). Mahar and colleagues found similar correlations (-0.66 and -0.65 respectively) between the Pacer and the Mile run.[16]

Whereas the correlations between Pacer and the Mile run are strong for both boys and girls, these tests are actually attempting to estimate $VO_2$max, which is the best measure of aerobic fitness. There is some evidence in the literature that girls display a higher correlation between $VO_2$max and performance on the Pacer than boys.[17] Gender differences and gender interactions in these tests have been noted by other researchers.[16,18] Maher notes that the motivation required for maximal performance on the Pacer test is probably less than the motivation needed for maximal performance on the Mile run, which requires a high level of motivation throughout the entire test.[16] Thus, it is possible that $VO_2$max is better correlated with academic performance than either the Mile run or the Pacer, but the Pacer is better associated with $VO_2$max in girls while the Mile run is better associated with $VO_2$max in boys. The gender difference in this aerobic fitness/academic performance association may also be due to social, physiological, or some other reason that is not known. For example, it is possible that in the Mile run, girls that have higher ability will match speed with slower friends whereas boys do not. Additional studies are needed to assess a more dynamic model of fitness and academic achievement within the larger psychosocial and emotional context.

### *Limitations*

This study has several design limitations. The data is cross-sectional in nature, and therefore, the results obtained do not indicate that higher levels of aerobic fitness caused improved academic achievement or vice versa. Also, FITNESSGRAM tests were administered by different PE teachers across schools. Despite training and review, there were most likely minor differences in how the aerobic fitness tests were implemented. WESTEST results were categorical and actual scores on these tests were not available. Tests like FITNESSGRAM and WESTEST are one-time events, and if a child was ill or otherwise impaired, results would not be a true reflection of their ability to perform. Furthermore, athletic ability amongst children varies and may have an impact on healthy zone determination or self-efficacy regarding the assessment. Finally, students

**Table 1. *t*-statistic for all WESTEST Subjects for Children Able to Run the Mile in Less than the Listed Time (in seconds) vs. Slower Children**

| Mile Times (seconds) | Boys: # faster vs. # slower | Reading | Math | Science | Social Studies | Girls: # faster vs. # slower | Reading | Math | Sci-ence | Social Studies |
|---|---|---|---|---|---|---|---|---|---|---|
| 440 | 20/221 | 3.36*** | 2.13 | 1.46 | 1.92 | | | | | |
| 460 | 38/203 | 3.03** | 2.29 | 1.01 | 1.86 | | | | | |
| 480 | 48/193 | 3.15** | 2.84** | 1.24 | 1.90 | | | | | |
| 500 | 60/181 | 3.58*** | 3.62*** | 1.92 | 2.85** | 20/210 | 2.43 | 1.03 | 2.14 | -0.15 |
| 520 | 65/176 | 4.00*** | 4.24*** | 2.36 | 3.31*** | 28/202 | 2.66** | 0.95 | 1.91 | 0.02 |
| **540** | 74/167 | **4.45*** ** | **4.81*** ** | **3.18**** | **3.77*** ** | 33/197 | 3.10** | 1.04 | 1.79 | -0.14 |
| Cohen's D | effect | **0.616** | **0.679** | **0.439** | **0.511** | | | | | |
| 560 | 82/159 | 3.76*** | 4.05*** | 2.74** | 3.16** | 42/188 | 2.40 | 1.10 | 1.33 | 0.24 |
| 580 | 90/151 | 3.45*** | 3.36** | 1.87 | 2.30 | 47/183 | 2.64** | 1.19 | 1.28 | 0.41 |
| 600 | 102/139 | 3.81*** | 3.86*** | 3.36 | 2.61** | 54/176 | 3.23*** | 1.84 | 1.79 | 0.78 |
| 620 | 110/131 | 3.69*** | 3.57*** | 2.33 | 2.42 | 74/156 | 3.62*** | 1.43 | 2.02 | 0.62 |
| 640 | 120/121 | 3.27*** | 3.23*** | 1.95 | 2.58** | 87/143 | 3.19** | 1.02 | 1.82 | 1.02 |
| 660 | 138/103 | 2.40 | 2.54 | 1.60 | 1.72 | 102/128 | 2.53** | 0.34 | 1.12 | -0.08 |
| 680 | 153/88 | 2.68 | 1.98 | 1.40 | 1.80 | 121/109 | 2.30 | 0.19 | 1.08 | -0.26 |
| 700 | 163/78 | 2.63 | 2.84** | 2.04 | 2.35 | 132/98 | 1.58 | 0.00 | 1.34 | -0.04 |
| 720 | 177/64 | 1.83 | 2.01 | 1.31 | 1.10 | 139/91 | 1.73 | 0.29 | 1.50 | 0.30 |
| 740 | 185/56 | 1.65 | 1.64 | 2.08 | 1.48 | 144/86 | 1.56 | 0.90 | 1.70 | 0.45 |
| 760 | 189/52 | 0.98 | 1.53 | 1.85 | 1.24 | 152/78 | 1.51 | 1.65 | 1.79 | 1.10 |
| 780 | 197/44 | 1.82 | 2.49 | 2.77 | 2.26 | 159/71 | 2.02 | 1.81 | 1.99 | 1.31 |
| 800 | 203/38 | 2.03 | 2.38 | 2.55 | 2.33 | 163/67 | 1.76 | 1.51 | 1.77 | 1.20 |
| 820 | 211/30 | 1.70 | 1.81 | 2.32 | 1.89 | 175/55 | 1.29 | 1.10 | 1.08 | 0.47 |
| 840 | 215/26 | 1.31 | 1.25 | 2.09 | 1.64 | 184/46 | 1.38 | 1.13 | 0.67 | 0.33 |
| 860 | 217/24 | 1.32 | 1.20 | 2.36 | 1.51 | 187/43 | 1.54 | 1.49 | 0.73 | 0.49 |
| 880 | | | | | | 192/38 | 1.17 | 1.71 | 0.55 | 0.49 |
| 900 | | | | | | 193/37 | 1.30 | 1.85 | 0.88 | 0.85 |
| 920 | | | | | | 202/28 | 1.00 | 1.52 | -0.37 | 0.74 |
| 940 | | | | | | 210/20 | -0.56 | 0.97 | -0.94 | -0.14 |

** $P < 0.01$ level; *** $P < 0.001$ level

in the study were predominantly Caucasian and representative of an average West Virginia school district, but the results may not translate well to other areas of the country with more ethnic diversity.

## TRANSLATION TO HEALTH EDUCATION PRACTICE

There is a growing body of evidence that indicates a significant positive relationship exists between physical fitness and cognitive function [2-8] in children. Other research documents positive associations between increased levels of physical activity and academic achievement[10] or cognitive performance.[2,19] This study identifies target points which, if achieved, could possibly confer a benefit to academics. If a fifth grade boy can complete the Mile run in 9 minutes or less and if a girl can score around a 30 on the Pacer, they have a higher probability of doing better academically. The significance of this opportunity may be more powerful for those students who are not fit but can become fit over time and, thus, increase the opportunity for improvements in their academic performance. It is hoped that the identification of these thresholds will lead to a more targeted approach for physical activity interventions.

**Table 2. Mean Comparisons for all WESTEST Subjects among Children Who Completed the Number of Circuits and More vs. Slower Children**

| # of circuits | Boys: # w/fewer vs. # at or above | Reading | Math | Science | Social Studies | Girls: # w/fewer vs. # at or above | Reading | Math | Science | Social Studies |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | | | | | | 63/626 | -2.10 | -3.40*** | -1.99 | -1.28 |
| 12 | 78/616 | 1.96 | -1.03 | 0.14 | 0.39 | 116/573 | -3.30*** | -4.34*** | -3.18** | -2.09 |
| Cohen's D | effect | | | | | | 0.328 | 0.446 | 0.327 | 0.216 |
| 14 | 108/586 | -0.91 | -0.28 | 0.96 | 0.62 | 162/527 | -3.21*** | -3.62*** | -2.90** | -1.56 |
| 16 | 153/541 | -0.64 | -0.61 | 1.21 | 0.80 | 230/459 | -2.95** | -3.55*** | -2.72** | -2.00 |
| 18 | 194/500 | -1.09 | -1.04 | 0.97 | 0.53 | 291/398 | -2.64** | -3.22*** | -2.67** | -1.30 |
| 20 | 218/476 | -1.07 | -0.55 | 1.12 | 0.54 | 330/359 | -2.12 | -3.03** | -2.61** | -1.20 |
| 22 | 251/443 | -1.25 | -0.98 | 0.95 | -0.06 | 385/304 | -3.01 | -3.57*** | -3.28*** | -2.45 |
| 24 | 311/383 | -0.91 | -0.73 | 0.74 | 0.18 | 439/250 | -2.95** | -2.86** | -1.89 | -1.97 |
| 26 | 364/330 | -1.09 | -1.03 | 0.61 | -0.33 | 481/208 | -3.27*** | -3.52*** | -1.34 | -1.92 |
| 28 | 393/301 | -1.58 | -1.17 | 0.31 | -0.45 | 507/182 | -4.07*** | -3.86*** | -2.28 | -2.68** |
| 30 | 413/281 | -1.17 | -0.71 | 0.66 | -0.23 | 531/158 | -4.72*** | -4.10*** | -2.48 | -3.02** |
| Cohen's D | effect | | | | | | 0.441 | 0.380 | 0.229 | 0.288 |
| 32 | 458/236 | -1.49 | -1.05 | 1.01 | -0.19 | 563/126 | -4.39*** | -3.45*** | -1.79 | -2.27 |
| 34 | 494/200 | -1.20 | -0.96 | 1.15 | -0.53 | 590/99 | -4.12*** | -3.17** | -1.68 | -2.98** |
| 36 | 515/179 | -0.37 | -0.66 | 1.74 | -0.14 | 600/89 | -4.13*** | -3.14** | -1.93 | -2.99** |
| 38 | 528/166 | -0.56 | -0.64 | 1.73 | -0.26 | 606/83 | -4.47*** | -3.32*** | -1.98 | -3.26*** |
| 40 | 538/156 | -0.83 | -0.98 | 1.35 | -0.39 | 607/82 | -4.26*** | -3.09** | -1.90 | -3.02** |
| 42 | 566/128 | -0.47 | -0.12 | 2.02 | 0.45 | 626/63 | -3.00** | -1.91 | -0.88 | -2.09 |
| 44 | 592/102 | -1.18 | -0.76 | 1.35 | 0.45 | | | | | |
| 46 | 609/85 | -1.10 | -0.71 | 1.53 | 0.81 | | | | | |
| 48 | 613/81 | -1.06 | -0.52 | 1.42 | 0.79 | | | | | |
| 50 | 617/77 | -1.15 | -0.60 | 1.18 | 0.77 | | | | | |

** $P < 0.01$ level; *** $P < 0.001$ level

The relationships between physical activity, physical fitness and academic performance are poorly understood. Hillman et al. documented improved performance in cognitive testing in preadolescent children after a single 20-minute treadmill walk compared to a control group.[20] Davis and colleagues conducted a controlled 15-week intervention with overweight, sedentary children randomized into low-dose (20 minutes/day exercise), high-dose (40 minutes/day), or control groups. Low- and high-dose groups participated in similar intensity exercise 5 days/week but for different lengths of time. Children's posttest scores indicated improved cognitive function (i.e., executive function) in the high-dose group.[9]

Much work remains with regard to strength, length and frequency of dose as well as whether it is the physical activity in general or the resulting physical fitness that affects academic performance. Furthermore, a wide range of other factors are known to affect academic performance. A fact sheet developed by the Food Research & Action Center references recent research linking breakfast and academic performance.[21] A Healthy Youth web-link created by the Centers for Disease Control and Prevention cites research linking poor school performance to both health-related factors (e.g. hunger, abuse, chronic illness) and health-risk factors (e.g. substance abuse, violence, physical inactivity).[22] Gender, parent education and socio-economic status have well-known effects on a child's school performance. Unfortunately, many of these factors are not generally open to intervention at school. The data presented

**Table 3. Correlation Coefficients of FITNESSGRAM Aerobic Fitness Times/Circuits with WESTEST Scores**

| FITNESSGRAM test | Reading | Math | Science | Social Studies |
|---|---|---|---|---|
| Boys mile | -0.229*** | -0.220*** | -0.198** | -0.181** |
| Girls mile | -0.144 | -0.064 | -0.074 | -0.044 |
| Boys pacer | 0.056 | 0.035 | -0.059 | -0.026 |
| Girls pacer | 0.160*** | 0.161*** | 0.104** | 0.120** |

** $P < 0.01$ level; *** $P < 0.001$ level

**Table 4. Average WESTEST Scores for Children who Attained Thresholds of Fitness**

| Test | Reading | Math | Science | Social Studies |
|---|---|---|---|---|
| Boys mile (540 seconds) | | | | |
| 75 faster students | 3.75*** | 3.37*** | 3.69** | 3.48*** |
| 166 slower students | 3.26 | 2.91 | 3.39 | 3.12 |
| Girls pacer (12 circuits) | | | | |
| 546 faster students | 3.33*** | 3.34*** | 3.38** | 3.24 |
| 144 slower students | 3.03 | 2.99 | 3.13 | 3.07 |
| Girls pacer (30 circuits) | | | | |
| 144 faster students | 3.43*** | 3.37*** | 3.35 | 3.22** |
| 546 slower students | 3.18 | 3.20 | 3.29 | 3.16 |

** $P < 0.01$ level; *** $P < 0.001$ level

in this study is exciting because it indicates an area open to school-based intervention, namely a child's aerobic fitness, could have a moderate impact on academic performance. No matter a child's gender, socio-economic status, BMI, or perhaps even home conditions or IQ, if he/she can increase aerobic fitness, his/her academic performance may improve.

Existing programs, at least for those students who choose to participate, seem to support this concept. Academically at-risk students who attended Zero Hour PE at Naperville Central High School (Illinois) showed improvement in reading and comprehension beyond that of other literacy students who did not attend the before-school PE class.[23] The Students Run LA running program cites improved attendance and grades as well as diminishing discipline issues in students who finish the marathon.[24] Students Run Philly Style, a program based on the Los Angeles initiative, notes increasing high school graduation rates, improving health and development of positive relationships with caring adults.[25]

As previously discussed, time away from the desk does not appear to interfere with academic achievement. In addition, health instruction and opportunities to learn and practice healthy lifestyle behaviors are considered health education curriculum. A certified physical education teacher has the skills to develop fun age- and developmentally-appropriate programming across the school day to assist students at any level of fitness to improve their aerobic capacity. In physical education, learning through station-based centers, group activities with adequate equipment (e.g.. ball for every student), and strategies such as monthly fitness testing can support increased physical activity and increased fitness as well as student goal setting and the pride that accompanies goal attainment. In health education and the regular classroom, cross-curricular lessons and thematic units can build physical activity and fitness into geography, math, science, history, reading and writing (e.g. walk across a state, to the moon, competitions between grades). Activity-supporting equipment such as pedometers and heart rate monitors can be incorporated into physical education, health education and cross-curricular units across many content areas. Club activities (walking, running, Dance, Dance Revolution) are yet one more avenue of increased physical activity during the school day. These types of interactive units, if designed in enjoyable formats, can, along with a PE curriculum designed to teach lifetime activity skills, increase participation in physical activities and encourage a broader range of positive health behaviors.

Within the complex matrix of indicators that affect academic achievement, physical fitness does appear to be at least one portal for improved health and improved academic achievement. Recent trends in childhood

**Figure 1. Mean Comparisons for Mile Times (20 Second Sections) in Boys**

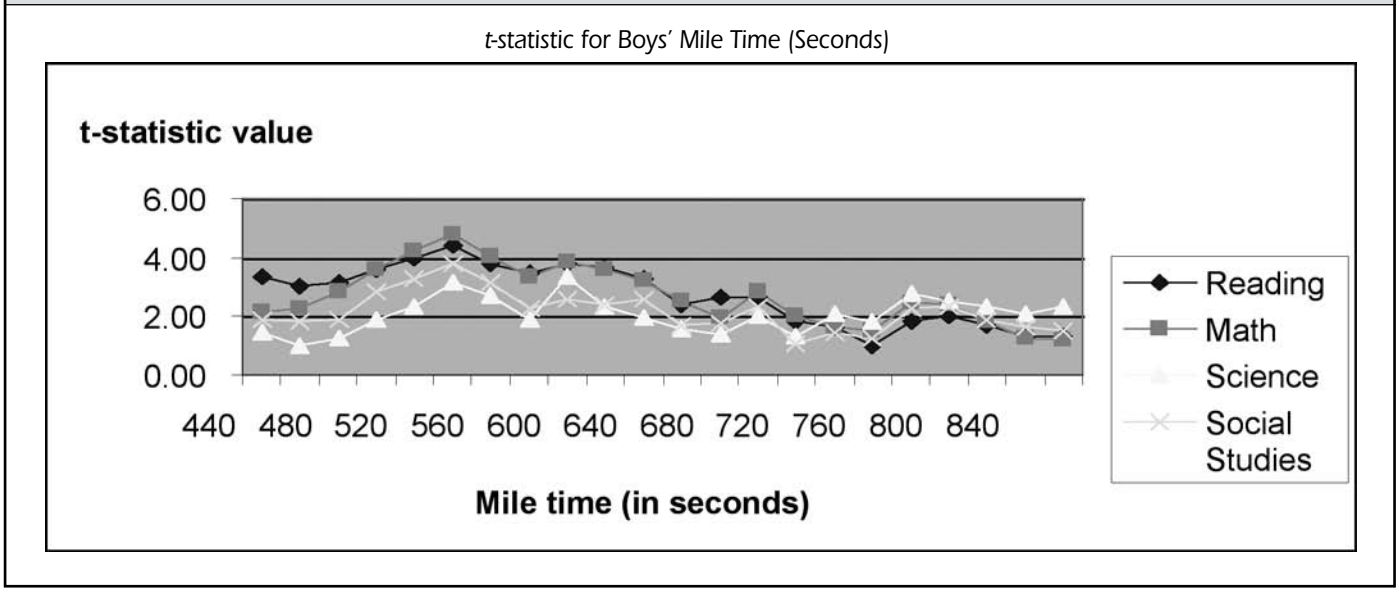
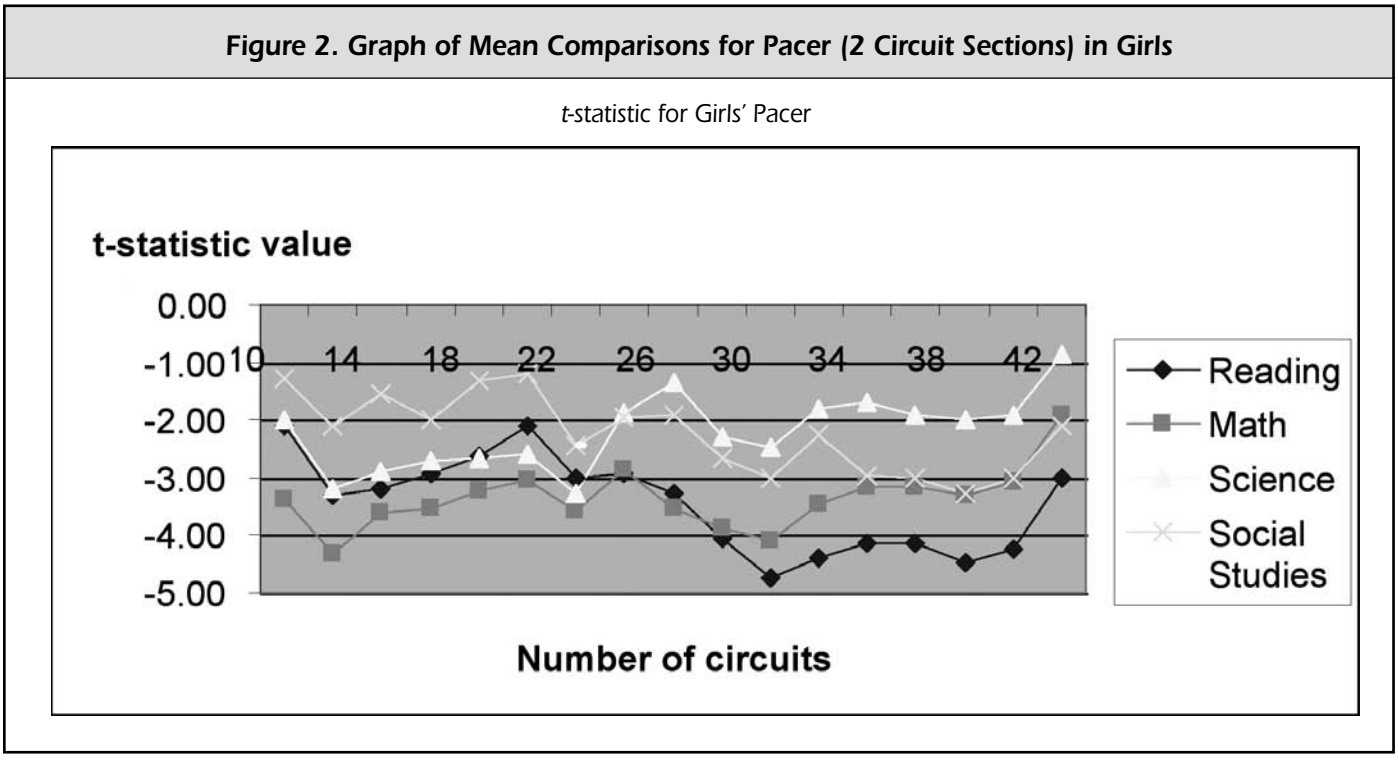



**Figure 2. Graph of Mean Comparisons for Pacer (2 Circuit Sections) in Girls**




obesity, childhood obesity as a predictor of adult obesity, and health risk factors associated with obesity are serious public health concerns. Increasing physical activity and/or physical fitness during the school day may address multiple issues through a single intervention.

No federal laws require physical education, nor do incentives for physical education programming exist.[26] School physical education can be a significant avenue of opportunity to increase moderate to vigorous physical activity in students and, ultimately, improve aerobic fitness levels. Leadership from school wellness councils and administrators can support translation of physical education/activity initiatives into sustainable policy-supported programming. Policies that increase aerobic activity opportunities in school settings may also increase overall academic performance, encourage

positive health habits, and improve immediate and future overall health.

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