Published in final edited form as:
Arch Pediatr Adolesc Med. 2009 November ; 163(11): 1014–1021. doi:10.1001/archpediatrics.2009.181.

Physical activity opportunities associated with fitness and weight status among adolescents in low-income communities

Kristine A. Madsen, MD, MPH, **Wendi Gosliner, MPH, RD**, **Gail Woodward-Lopez, MPH, RD**, and **Patricia B. Crawford, DrPH, RD**

Abstract

Objective—To identify physical activity opportunities linked to fitness and weight status among adolescents in low-income communities.

Design—Cross-sectional, ecological analysis.

Setting—19 public schools participating in The California Endowment's Healthy Eating Active Communities program.

Participants—9,268 7th and 9th grade students.

Outcome Measures—Cardiorespiratory fitness (mile time) and body mass index (BMI). Independent variables: students' perceptions/behaviors related to daily physical activity opportunities, assessed via anonymous survey. Ecological analysis was employed to link survey and fitness/BMI data within each school. Linear regression identified associations between youth's perceptions/behaviors and fitness/BMI.

Results—As the proportion of students reporting 1) liking PE, 2) walking to school, and 3) spending ≥20 mins in exercise during PE, increased from 0% to 100%: 1) mile time decreased overall (−2.7 mins, p=0.028); 2) mile time decreased among 7th graders (−3.3 mins, p=0.019); and 3) BMI z-score decreased among 9th graders (−0.7, p<0.045), respectively. Each additional day students reported being active on school grounds outside school was associated with decreased mile time (−0.5 mins, p<0.019). Active transport to school was associated with *poorer* weight status and greater odds of purchasing food (OR=1.5, p<0.01) while in transit.

Conclusion—This study suggests that PE is a valuable policy opportunity to improve student health. Promoting active transport may improve fitness, but must be done in conjunction with community partnerships to improve the food environment in the vicinity of schools. Promoting the use of school grounds outside of school (such as after-school programs) should also be prioritized in response to youth obesity.

INTRODUCTION

The dramatic rise in obesity in the United States over just 3 decades implicates environmental changes that contribute to positive energy balance. Of particular concern is the disproportionate impact on youth living in disadvantaged areas, who are at high risk of physical inactivity, obesity, and cardiovascular disease and mortality.[1, 2]

Policies aimed at supporting environmental change in low-income communities will be critical to reverse trends in obesity,[3] but it is unclear where to focus efforts to achieve the

Corresponding author: Kristine A. Madsen, MD, MPH, University of California, San Francisco, Dept of Pediatrics, 3333 California Street, Box 0503, San Francisco, CA 94118, Office: 415-514-2445, Fax: 415-476-6106, madsenk@peds.ucsf.edu.

No conflicts of interest.

greatest initial impact. Additionally, school leaders refining their newly mandated wellness policies[4] need evidence as to the factors most strongly associated with student health. To appropriately target resources and intervention efforts, it is important to identify environmental factors most strongly implicated in child health.

Physical activity and fitness are strong predictors of cardiovascular risk among youth and adults, independent of weight status.[5, 6] Despite the known benefits of physical activity, activity declines through adolescence[7] and is consistently lower among low-income youth.[8, 9] Environmental interventions to address disparities in physical activity are critical to prevent further disparities in cardiovascular morbidity. We therefore sought to identify those physical activity opportunities most strongly associated with student health (cardiorespiratory fitness and weight status) among adolescents in low-income communities, and to determine if associations were different in middle and high schools. The California Endowment's Healthy Eating Active Communities program provided a unique opportunity to examine this relationship among diverse 7th and 9th grade students.

METHODS

Healthy Eating Active Communities

Healthy Eating Active Communities (HEAC) is a multi-year program of The California Endowment to help communities transform nutrition and physical activity environments to promote healthy eating and active living (www.healthyeatingactivecommunities.org). Six geographically diverse low-income communities throughout California were funded to make changes in a variety of sectors: schools, neighborhoods, after school programs, healthcare, and media/marketing environments.

This report focuses on data (a survey assessing student attitudes, behaviors, and perceptions related to their physical activity and nutrition environments, and a battery of fitness assessments conducted as part of the state-mandated Fitnessgram[10]) collected from students at 19 schools.

Participants

Participants were 7th grade students in 9 middle schools, 9th grade students from 9 high schools, and 7th and 9th grade students from one combined school. The 19 public schools represented a diverse mix of races/ethnicities. While HEAC interventions at the school level are district-wide, participating schools were selected based on involvement in intervention strategies in the 6 HEAC communities. Data from 3 comparison schools, matched on participation in free/reduced priced lunch, ethnic profile of students, geographic area (urban/rural, northern/southern CA), and school size, are included. Based on classifications from U.S. Census Bureau data, 7 schools were in large urban communities (population ≥250,000), 8 in mid-sized urban communities (population <250,000), and 4 in urban fringe (territory in metropolitan statistical area [MSA])/small towns (outside MSA, population <25,000). The proportion of students at each school eligible for free or reduced-price lunch was obtained from the California Department of Education (CDE) Dataquest website (http://data1.cde.ca.gov/dataquest).

This study was approved by U.C. Berkeley's Committee for the Protection of Human Subjects.

Survey Methods

Survey questions were adapted whenever possible from existing instruments designed to measure similar concepts.[11, 12] The initial survey was modified after pilot testing with

middle school students for language and concept comprehension and time required to complete. The final instrument consisted of 40 items (total of 138 subitems) in multiple choice and Likert-scale format and was available in English and Spanish.

Surveys were administered by trained research staff, using a standardized protocol, on a weekday other than Monday Based on school preference, surveys were administered during physical education classes in 13 schools and during homeroom, Language Arts, English or Computer class in six other schools. At schools with greater than 400 students enrolled in a grade, classes were randomly selected to complete the survey (sample ranged from 259 to 397 students). Parents received a letter prior to survey administration explaining the purpose of the survey and provided passive consent in all cases.

Overall, 2564 7th grade students (50% female) and 2793 9th grade students (49% female) completed the survey anonymously (200 students completed the survey in Spanish). Students were told that participation was voluntary; fewer than 0.5% of students refused. Students reported their gender and grade, and indicated their race/ethnicity by selecting 1 or more of the following categories: Asian, American Indian/Alaska Native, Hawaiian/Pacific Islander, African American, Hispanic/Latino, White, or Other. In analyses, students were considered Hispanic if they selected Hispanic alone or in combination with other race categories. Students were classified as mixed race if they reported more than 1 non-Hispanic race.

Survey Questions related to Physical Activity

This study focuses on youth's routine opportunities for physical activity. Students reported on mode of transportation to school (day of survey) and from school (day prior to survey) and PE enrollment (none, part-year or all-year). Students taking PE responded to a 4-point Likert scale assessing enjoyment of PE ("I don't like PE at all" to "I like PE a lot") and estimated the number of minutes spent "exercising or moving around" during PE class: 0–10 minutes, 10–20 minutes, 20–30 minutes or more than 30 minutes. Seven separate items assessed the number of days in the prior week on which youth used outdoor facilities (park, skatepark, sports field or ball court), indoor facilities (recreation or youth center, indoor skate park or ball court), bike or jog paths, schools, or did physical activity in their neighborhood or on sports teams/classes.

Among other nutrition-related questions, students indicated whether they bought food from snack carts or trucks, fast food restaurants, or stores, on their way to or from school.

Fitness and BMI Data

Mile run times and height and weight were assessed as part of the Fitnessgram, a battery of field tests assessing student fitness.[10] The California Department of Education (CDE) requires that all 5th, 7th and 9th grade students participate in Fitnessgram assessments each year. Trained administrators at each school conducted the Fitnessgram according to the directions in the Fitnessgram manual.[10] The researchers provided additional documentation on proper administration, the PE-AIM-101 Portable Stadiometer (Perspective Enterprises, Inc., Portage, MI) to measure height, and the Digital Healthcare Scale (Tanita, Tokyo, Japan). Height was measured to the nearest inch and weight recorded to the nearest pound with students in indoor clothes and shoes off. Cardiorespiratory fitness was assessed with the one-mile run in 99% of students (1% completed the walk test). Teachers were to allow practice pacing prior to completing the mile-run and to instruct students to complete the distance as quickly as possible, even if they needed to walk. Times were recorded in minutes and seconds. We assume that faster mile times are a proxy for greater cardiorespiratory fitness. The CDE provided data on 9,268 students: anonymous height and weight data for

3,463 7th grade students (50% female) and 4,345 9th grade students (49% female), and mile-run time for 3,857 7th grade students (49% female) and 4,958 9th grade students (48% female), along with age and race/ethnicity (parents indicated their child's race/ethnicity from a list of possible choices during school registration). BMI z-scores were calculated according to the CDC guidelines using growth reference data from 2000.[13]

Data Analysis

In order to link anonymous student survey data to Fitnessgram results, an ecological approach was employed, which involved aggregating survey response data and Fitnessgram measures for each group of students of the same grade, sex, and ethnicity within each school (Figure 1). Aggregate mile time and BMI z-scores for each group could thereby be linked to aggregate survey response scores for the identical group. Within groups, means summarized mile run time, BMI z-score, and survey items assessing number of days per week students engaged in various activities. The proportion of students responding "yes" summarized yes/no items (active transport to school, being excused from PE for sports or for other reasons, taking PE all year, and purchasing food from specific locations on the way to/from school), and the proportion responding *Always* or *Often* (i.e. 2 highest responses from a 4-point response scale) summarized questions regarding access to facilities for physical activity. Similarly, the proportion of students reporting at least 20 minutes spent "exercising or moving around" during PE and the proportion liking PE "a lot" or "a little bit" (vs. not liking) was calculated for each group.

Calculations were performed within Stata version 9.2 (Stata Corporation, College Station, TX). Linear regression, taking clustering by school into account (cluster option in Stata), examined the relationship between mile time (or BMI z-scores) and survey items. Analyses were frequency weighted by the number of students in each group with at least 1 Fitnessgram assessment. (*All* 7th and 9th grade students are expected to undergo the Fitnessgram assessment; surveys, when not administered to all students in a school, were intentionally administered to capture a representative sample.) Regression analyses included grade, sex, and a grade*sex interaction term to account for the expected and potential differences in mile time and BMI z-score by grade and sex, and by sex within grade. To account for contextual factors (environmental characteristics common to students), the proportion of students eligible for free/reduced-price lunch (a proxy for neighborhood SES) and the community's urbanization level (treated as a categorical variable) were included in an adjusted model. Finally, we examined interaction terms in all the models to see if grade (i.e. middle vs. high school) modified the association between the survey and Fitnessgram items being examined; stratified models were created if interaction was suggested ($p<0.20$ for interaction term). To better understand group-level relationships that emerged from primary analyses, we calculated odds ratios at the individual level for the relationship between active transport and purchasing foods from food carts on the way to/from school.

RESULTS

Table 1 shows student demographics and average scores for Fitnessgram data. Almost half of the youth in these low-income communities were overweight or obese (BMI above the 85th percentile for age and sex), and over half did not meet recommended fitness standards. Table 2 summarizes survey responses.

Associations between opportunities for physical activity and fitness

Use of bike/jog paths was significantly associated with greater cardiorespiratory fitness (lower mile times), while availability of indoor facilities was significantly associated with poorer fitness (higher mile times). Adjusting for contextual factors diminished the

association between use of bike/jog paths and fitness, and completely attenuated the relationship with indoor facilities. Liking PE and use of school grounds outside of school were significantly associated with greater fitness, and walking to school showed a trend toward greater fitness in the adjusted model.

Including a grade interaction term demonstrated stronger associations with fitness for 7th than 9th graders. Table 4 includes variables for which significant associations ($p<0.05$) arose in analyses stratified by grade. Figure 2 demonstrates that going from 50% to 100% of students reporting that they liked PE was associated with a mean improvement in mile time of 2.5 minutes for 7th graders ($p=0.02$) and about a half-minute improvement for 9th graders ($p=0.45$). Each mean additional day that groups of 7th graders reported using school grounds was associated with a 1-minute decrease in mile time (Table 4). Mile times were faster by 3 minutes going from 0% to 100% of students walking to school and by almost 6 minutes going from 0% to 100% of students taking PE full-year, in the contextual model (Table 4). Most relationships went in similar directions for 9th graders but did not approach statistical significance.

Associations between opportunities for physical activity and BMI z-scores

Overall, relationships between weight status and survey responses were contrary to expectations. Student groups reporting higher rates of active transport (to or from school) had higher average BMI z-scores. Analyses at the individual level (survey data only) demonstrated that active commuters were significantly more likely to purchase food on their way to/from school than were passive commuters (OR = 1.5, 95% CI 1.3 to 1.8). Relationships between active transport and BMI z-score were no longer significant in models adjusted for the purchase of food from snack carts while in transit.

Students reporting at least 20 minutes of exercise during PE tended to have lower BMI z-scores ($p=0.127$), with apparent interaction by grade. For 9th graders, going from 38% to 80% of students reporting at least 20 minutes of physical activity during PE (the range across schools) was significantly associated with a 0.3 unit smaller BMI z-score (Table 4), with a trend toward the same association in the contextual model. For a 14 year-old male of average height, with the average BMI z-score (0.8) for this population, a 0.3 unit change in BMI z-score is equivalent to about a 1 kg/m^2 change in BMI.

Adjusting for SES and urbanization level, student groups reporting more days/wk of sports team participation had higher BMI z-scores.

DISCUSSION

The California Endowment's HEAC program aims to support environmental changes to prevent child (and adult) obesity and prevent future cardiovascular morbidity. This investigation focused on youth's opportunities for physical activity as areas for potential intervention. Given the high prevalence of obesity and low levels of fitness seen in this study, youth in these communities are at great risk of future cardiovascular morbidity and mortality. A major strength of this study is the use of objective measures of weight status and fitness in conjunction with youth's perceptions of all major opportunities for physical activity in low-income communities. Perceptions, though subject to reporting bias, reflect what youth experience as their reality and can take into account practical issues (e.g., barriers related to access) that objective measures might not. Additionally, perceptions can be more closely linked to youth's behaviors than external measures.[9]

Among these at-risk adolescents, physical education stands out as the highest impact area. All facets of PE – exposure, intensity, enjoyability – positively impacted student health.

These findings contribute to a growing body of literature identifying the importance of PE in increasing physical activity[14, 15] and fitness.[16–18] Although there is currently less evidence to link PE and weight status,[14] we demonstrate an association between more time spent exercising during PE and better weight status among 9th grade students. The cross-sectional nature of the present study prevents us from drawing causal inferences; however, 2 recent longitudinal studies among elementary school children support the hypothesis that greater exposure to PE predicts lower BMI.[16, 17] Further, we extend findings to date by focusing on youth at greatest risk of future cardiovascular disease and by examining PE within the framework of all youth's major opportunities for physical activity.

While California legislation mandates that all 7th and 9th grade students take PE, we found significant variation in PE participation in this study and up to 40% of students in some schools reported not taking a full year of PE. Further, while binding PE requirements are associated with greater physical activity during PE,[19] nearly half of students reported less than 20 minutes of moderate activity during PE. Although PE is clearly an important area for further intervention, schools must have financial support for it, governing bodies must demonstrate commitment to it, and policies surrounding it must have teeth. An example of such a policy is a proposed (and much-debated) mandate requiring that students pass a physical fitness test in order to graduate from high school in California.

While requiring a certain level of fitness prior to graduation translates readily into a policy with teeth, it does not address making PE enjoyable, yet the present findings suggest that groups of students who report higher enjoyment of PE have higher overall levels of fitness. Greater student enjoyment may reflect higher quality PE instruction that results in students putting forth greater effort. While students who like PE might simply be those who are more athletic to begin with, the present data don't support this phenomenon, as liking PE tended to be associated with slightly higher BMI z-scores. Thus, it's unlikely that athletic students drive the relationship between enjoyment and fitness. Similar to these findings, a recent study demonstrated that overweight high school students were just as active during PE as non-overweight students.[20] Further investigation identifying factors associated with enjoyment (e.g., instructor's training and experience, equipment and facility availability) will be necessary to translate this association into action.

While student groups reporting higher rates of active transport to/from school showed a trend toward better mile times, they also had significantly *higher* BMI z-scores. Active commuters may live very short distances from school (shorter distance to school has repeatedly been linked to active commuting21–23) such that the physical activity involved is minimal. Students being driven to school may also come from higher income families. It is also possible that those walking to or from school consume more calories because they purchase foods during their commute. We found that a significantly higher proportion of students using active transport purchased food from a snack cart while in transit than did students commuting by bus or car. Studies in low-income communities would suggest that the foods widely available near schools are not healthy.24, 25 Access to unhealthy foods just outside a school's doors can readily undermine schools' efforts to provide healthy environments. While a 15-minute walk may burn off 100 calories, a visit to a fast food establishment may layer on 500 calories in an even shorter time period. Policies, developed in collaboration with local vendors, to provide a "safer" nutrition environment in school zones, could address this, and model community-based interventions to create healthy environments have demonstrated some success.[26, 27]

Use of school grounds outside of school was significantly associated with greater fitness, particularly for 7th graders, which may reflect participation in after-school programs. After-school programs are an important health focus and recent studies in the after-school setting

have shown promise among elementary school children in low-income areas.[28, 29] While use of other recreational facilities was not significantly associated with fitness, based on 95% confidence intervals for these associations, we can't rule out an effect as large as a 1 minute improvement in mile time for each additional day of participation in these venues.

In the present study, reported utilization of physical activity facilities was linked to better fitness, but greater reported access to indoor facilities was associated with poorer weight status. It's possible that greater access to recreational facilities also means access to other venues that promote ill-health, such as fast food establishments. While our findings contradict those among adults linking greater access to recreational activities to lower rates of self-reported obesity,[30] the gap between providing access to facilities and getting youth to use them was well documented in a study by Rand in a low-income community in Southern California.[31] "Build it and they will come" may no longer apply and interventions aimed at increasing access without additional social marketing efforts or use of incentives may not succeed.

LIMITATIONS

Ecologic analyses, which may be appropriate for studying community-level associations, are subject to special bias (factors aggregated at the community level don't take into account variation in exposure within the community) and confounding, and, therefore, group-level associations demonstrated might not be true at the individual level.[32] The self-reported survey data are also subject to bias. Additionally, Fitnessgram results were available for only 72% to 99% of enrolled students across schools in this study. Because fitness testing is typically done during PE, some schools' results may preferentially reflect students taking PE. Given the high mean rates of participation in and enjoyment of PE reported here and minimal variability between groups, we may underestimate the effect of these factors. Similarly, although efforts were made to administer surveys in subjects other than PE, at many schools surveys were administered during PE class due to the schools' limited capacity to release time from other subjects.

While BMI is objective, it is does not distinguish between lean and fat mass; thus, a higher BMI z-score may reflect higher muscle mass in some students;33 e.g. higher BMI z-scores seen among sports team participants in this study could reflect higher muscle mass (certainly, other benefits accrue to youth participating in sports34). Additionally, fitness tests are effort dependent and fitness scores may reflect greater effort rather than greater fitness. However, students who put forth more effort during fitness testing are likely to make greater efforts throughout the year, not just during testing. While 9th grade students who reported at least 20 minutes of exercise during PE had lower BMI z-scores than their peers in unadjusted models, this cross-sectional association could reflect greater effort among leaner students. However, as noted, recent findings suggest overweight students are just as active as normal weight students in PE.[20]

CONCLUSION

These findings point to potential policy opportunities to improve student health in low-income communities: shaping PE that youth enjoy and increasing duration of participation, improving quality of PE classes in order to achieve higher levels of physical exertion, promoting student utilization of physical activity facilities at school and in the community, and working with neighborhood and community partners to surround youth with healthy options, particularly just outside schools' doors. Identifying appropriate incentives and developing monitoring systems in these areas should be prioritized in schools' and communities' response to youth obesity.

Acknowledgments

Funding provided by The California Endowment and Kaiser Permanente for the evaluation of the Healthy Eating Active Communities program and by NICHD K23HD054470-01A1 and American Heart Association 0865005F. No funders were involved in any aspect of the analyses contained herein or in the preparation of this manuscript.

REFERENCES

1. Pickett KE, Pearl M. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. J Epidemiol Community Health 2001;55(2):111–122. [PubMed: 11154250]
2. Yen IH, Syme SL. The social environment and health: a discussion of the epidemiologic literature. Annu Rev Public Health 1999;20:287–308. [PubMed: 10352860]
3. Ashe M, Feldstein LM, Graff S, Kline R, Pinkas D, Zellers L. Local venues for change: legal strategies for healthy environments. J Law Med Ethics 2007;35(1):138–147. [PubMed: 17341222]
4. Moag-Stahlberg A, Howley N, Luscri L. A national snapshot of local school wellness policies. J Sch Health 2008;78(10):562–568. [PubMed: 18808476]
5. Andersen LB, Harro M, Sardinha LB, et al. Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). Lancet 2006;368(9532):299–304. [PubMed: 16860699]
6. Blair SN, Kohl HW 3rd, Barlow CE, Paffenbarger RS Jr, Gibbons LW, Macera CA. Changes in physical fitness and all-cause mortality. A prospective study of healthy and unhealthy men. JAMA 1995;273(14):1093–1098. [PubMed: 7707596]
7. Kimm SY, Glynn NW, Kriska AM, et al. Longitudinal changes in physical activity in a biracial cohort during adolescence. Med Sci Sports Exerc 2000;32(8):1445–1454. [PubMed: 10949011]
8. Singh GK, Kogan MD, Siahpush M, van Dyck PC. Independent and joint effects of socioeconomic, behavioral, and neighborhood characteristics on physical inactivity and activity levels among US children and adolescents. J Community Health 2008;33(4):206–216. [PubMed: 18373183]
9. Madsen KA, McCulloch CE, Crawford PB. Parent Modeling: Perceptions of Parents' Physical Activity Predict Girls' Activity throughout Adolescence. J Pediatr. 2008
10. Welk, GJ.; Morrow, JRJ.; Falls, HBE. Fitnessgram Reference Guide. Dallas, TX: The Cooper Institute; 2002 [Accessed]. www.cooperinstitute.org/products/grams/documents/FITNESSGRAM_ReferenceGuide.pdf.
11. YRBSS. Youth Risk Behavior Surveillance System. 2008. www.cdc.gov/HealthyYouth/yrbs/index.htm
12. California Healthy Kids Survey. 2008. www.cde.ca.gov/ls/yd/re/chksdatacollection.asp
13. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, et al. CDC growth charts: United States. Adv Data 2000;(314):1–27. [PubMed: 11183293]
14. Kahn EB, Ramsey LT, Brownson RC, et al. The effectiveness of interventions to increase physical activity. A systematic review. Am J Prev Med 2002;22(4 Suppl):73–107. [PubMed: 11985936]
15. Trudeau F, Shephard RJ. Physical education, school physical activity, school sports and academic performance. Int J Behav Nutr Phys Act 2008;5:10. [PubMed: 18298849]
16. Datar A, Sturm R. Physical education in elementary school and body mass index: evidence from the early childhood longitudinal study. Am J Public Health 2004;94(9):1501–1506. [PubMed: 15333302]
17. Sollerhed AC, Ejlertsson G. Physical benefits of expanded physical education in primary school: findings from a 3-year intervention study in Sweden. Scand J Med Sci Sports 2008;18(1):102–107. [PubMed: 17490464]
18. Failing Fitness: Physical Activity and Physical Education in Schools. Los Angeles, CA: UCLA Center to Eliminate Health Disparities and Samuels & Associates; 2007 Jan. Funded by The California Endowment
19. Cawley J, Meyerhoefer C, Newhouse D. The impact of state physical education requirements on youth physical activity and overweight. Health Econ 2007;16(12):1287–1301. [PubMed: 17328052]

20. Hannon JC. Physical activity levels of overweight and nonoverweight high school students during physical education classes. J Sch Health 2008;78(8):425–431. [PubMed: 18651929]
21. Timperio A, Ball K, Salmon J, et al. Personal, family, social, and environmental correlates of active commuting to school. Am J Prev Med 2006;30(1):45–51. [PubMed: 16414423]
22. Kerr J, Rosenberg D, Sallis JF, Saelens BE, Frank LD, Conway TL. Active commuting to school: Associations with environment and parental concerns. Med Sci Sports Exerc 2006;38(4):787–794. [PubMed: 16679998]
23. Greves HM, Lozano P, Liu L, Busby K, Cole J, Johnston B. Immigrant families' perceptions on walking to school and school breakfast: a focus group study. Int J Behav Nutr Phys Act 2007;4:64. [PubMed: 18053259]
24. Sturm R. Disparities in the food environment surrounding US middle and high schools. Public Health 2008;122(7):681–690. [PubMed: 18207475]
25. Kipke MD, Iverson E, Moore D, et al. Food and park environments: neighborhood-level risks for childhood obesity in east Los Angeles. J Adolesc Health 2007;40(4):325–333. [PubMed: 17367725]
26. Romon M, Lommez A, Tafflet M, et al. Downward trends in the prevalence of childhood overweight in the setting of 12-year school- and community-based programmes. Public Health Nutr 2008:1–8.
27. Economos CD, Hyatt RR, Goldberg JP, et al. A community intervention reduces BMI z-score in children: Shape Up Somerville first year results. Obesity 2007;15(5):1325–1336. [PubMed: 17495210]
28. Robinson TN, Killen JD, Kraemer HC, et al. Dance and reducing television viewing to prevent weight gain in African-American girls: the Stanford GEMS pilot study. Ethn Dis 2003;13 Suppl 1(1):S65–S77. [PubMed: 12713212]
29. Weintraub DL, Tirumalai EC, Haydel KF, Fujimoto M, Fulton JE, Robinson TN. Team sports for overweight children: the Stanford Sports to Prevent Obesity Randomized Trial (SPORT). Arch Pediatr Adolesc Med 2008;162(3):232–237. [PubMed: 18316660]
30. Poortinga W. Perceptions of the environment, physical activity, and obesity. Soc Sci Med 2006;63(11):2835–2846. [PubMed: 16952415]
31. Cohen, D.; Sehgal, A.; McKenzie, TL.; Williamson, S.; Golinelli, D. Active Living Research. Washington, D.C.: 2008. Effects of Park Improvements on Park Use and Physical Activity: Policy and Programming Implications.
32. Wakefield J. Ecologic studies revisited. Annu Rev Public Health 2008;29:75–90. [PubMed: 17914933]
33. Ellis KJ, Abrams SA, Wong WW. Monitoring childhood obesity: assessment of the weight/height index. Am J Epidemiol 1999;150(9):939–946. [PubMed: 10547139]
34. Kjonniksen L, Anderssen N, Wold B. Organized youth sport as a predictor of physical activity in adulthood. Scand J Med Sci Sports. 2008

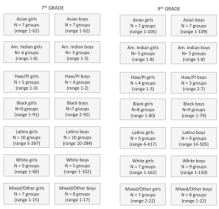

FIGURE 1.

Groups for which data were aggregated. (Within each school, subjects were grouped by grade, race/ethnicity, and sex; not all schools had students of every race/ethnicity. Range represents minimum and maximum number of subjects across groups.)

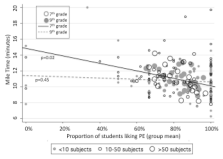

FIGURE 2.

Group means for proportion of students liking PE vs Mile Time with best fit regression lines (adjusted for sex, proportion of students eligible for free/reduced-price lunch, and urbanization level).

Table 1

Student characteristics from Fitnessgram data.

	# (%) or mean ± SD	[Range across schools]
Ethnicity		
African-American	743 (8.0%)	[0% – 31%]
Asian	459 (5.0%)	[0% – 51%]
Latino	6,763 (73.0%)	[10% – 99%]
White	1,003 (10.8%)	[0% – 79%]
Other	300 (3.2%)	[0% – 12%]
Female	4,526 (48.8%)	[43.2% – 53.8%]
BMI z-score (n=7,808)	0.8 ±1.0	[0.4 – 1.2]
Students with BMI ≥ 85th %tile	3,389 (43%)	[25% – 60%]
Mile run time (mins) (n=8,815)	11.1 ± 2.3	[8.8 – 13.7]
Students meeting recommended mile run time	4,241 (48%)	[21% – 89%]

Table 2

Survey Data

Sample means (± SD) or proportions with [ranges across schools]

	All Students n = 5357	7th Grade n = 2564	9th Grade n = 2793
School-related PA (% reporting Yes)			
Active transport to school*	29% [6%, 58%]	33% [15%, 58%]	25% [6%, 38%]
Active transport from school*	46% [15%, 78%]	51% [23%, 78%]	41% [15%, 67%]
Full-year PE Participation*	84% [60%, 99%]	92% [78%, 99%]	77% [60%, 89%]
Like PE	82% [71%,92%]	82% [74%, 94%]	83% [71%, 90%]
≥ 20 mins PA in PE*	57% [38%, 80%]	53% [38%, 80%]	62% [51%, 80%]
Access (Always or Often)			
Outdoor facilities available*	57% [46%, 70%]	59% [48%, 70%]	56% [46%, 68%]
Indoor facilities available*	38% [20%, 54%]	40.1% [20%, 53%]	36% [24%, 54%]
Facilities students like*	41% [28%, 50%]	43% [31%, 50%]	38% [28%, 49%]
Use (days/wk) of:			
Outdoor facilities*	1.9 ± 2.0 [1.4, 2.7]	2.1 ± 2.1 [1.4, 2.7]	1.8 ± 2.0 [1.6, 2.1]
Indoor facilities *	1.1 ± 1.8 [0.9, 1.4]	1.2 ± 1.8 [0.9, 1.7]	1.1 ± 1.7 [0.9, 1.2]
Bike or jog path*	1.9 ± 2.1 [1.5, 2.2]	2.0 ± 2.1 [1.5, 2.2]	1.8 ± 2.1 [1.4, 2.1]
Streets or yards for PA*	2.1 ± 2.2 [1.4, 3.2]	2.3 ± 2.3 [1.6, 3.2]	2.0 ± 2.2 [1.4, 2.5]
PA classes outside of school	0.9 ± 1.7 [0.6, 1.2]	0.9 ± 1.7 [0.7, 1.4]	0.9 ± 1.7 [0.6, 1.2]
Sports team participation*	1.4 ± 2.1 [0.8, 1.9]	1.6 ± 2.2 [0.9, 1.9]	1.2 ± 2.1 [0.8, 1.6]
PA on school grounds not during school*	1.4 ± 2.0 [0.9, 1.8]	1.4 ± 2.0 [1.3, 1.7]	1.3 ± 2.0 [0.9, 1.8]
Bought food from snack cart on way to/from school	12% [2%, 26%]	14% [5%, 26%]	10% [2%, 20%]

PA: physical activity

*7th and 9th grade proportions (or means) different ($p<0.05$) by chi-squared (or t-test)

Table 3

Adjusted associations between PA opportunities and Mile Time and BMI z-score.

	Mile Time (mins) Beta [95% CI]		BMI z-score Beta [95% CI]	
	Simple model	Model w/ contextual factors	Simple model	Model w/ contextual factors
School-related PA (% reporting Yes)				
Active transport to school	−2.4 [−5.7, 0.9]*	−2.0 [−4.2, 0.2]*	**0.7 [0.3, 1.1]***	**0.4 [0.0, 0.8]***
Active transport from school	−1.4 [−3.9, 1.2]	−0.8 [−2.6, 0.9]	**0.5 [0.2, 0.8]**	**0.3 [0.1, 0.6]**
Full-year PE Participation	−1.0 [−3.0, 1.0]*	−0.5 [−2.5, 1.6]*	0.2 [−0.3, 0.7]	0.2 [−0.2, 0.6]
Like PE	−3.4 [−7.6, 0.9]*	**−2.7 [−5.0, −0.3]***	0.4 [−0.2, 1.0]	0.3 [−0.2, 0.8]
≥ 20 mins of PA in PE	0.4 [−2.9, 3.7]	−0.6 [−3.0, 1.7]	−0.3 [−0.8, 0.1]*	−0.3 [−0.7, 0.2]
Access (% reporting Always or Often)				
Outdoor facilities available	0.8 [−1.7, 3.3]	−1.1 [−3.1, 1.0]	0.3 [−0.3, 0.9]	0.3 [−0.0, 0.7]
Indoor facilities available	**2.8 [0.4, 5.3]**	0.1 [−2.0, 2.2]*	**0.5 [0.0, 0.9]**	0.2 [−0.1, 0.5]
Facilities students like available	0.7 [−2.1, 3.4]	−0.6 [−2.7, 1.6]	−0.0 [−0.7, 0.7]	0.2 [−0.2, 0.5]
Use of facilities (days/wk)				
Outdoor facilities	−0.1 [−0.6, 0.5]	−0.2 [−0.7, 0.3]	−0.0 [−0.2, 0.1]	0.0 [−0.1, 0.1]
Indoor facilities	−0.2 [−0.9, 0.6]	−0.2 [−0.8, 0.3]	0.0 [−0.1, 0.2]	0.0 [−0.1, 0.2]
Bike or jog path	**−0.8 [−1.4, −0.2]***	−0.5 [−1.2, 0.3]*	−0.0 [−0.2, 0.2]	0.1 [−0.1, 0.2]
Streets or yards for PA	0.2 [−0.3, 0.8]	0.1 [−0.2, 0.4]	0.0 [−0.2, 0.2]	0.1 [−0.1, 0.2]
PA classes outside of school	0.1 [−0.6, 0.7]	−0.2 [−0.7, 0.4]	0.1 [−0.1, 0.2]	0.1 [−0.0, 0.2]
Sports team participation	0.0 [−0.6, 0.7]	0.3 [−0.8, 0.2]	0.1 [−0.1, 0.3]	**0.1 [0.0, 0.3]**
PA on school grounds not during	−0.3 [−0.7, 0.1]*	**−0.5 [−1.0, −0.1]***	−0.1 [−0.2, 0.1]	−0.0 [−0.1, 0.1]

All models include grade, sex, and a grade*sex interaction term, take clustering by school into account, and are frequency weighted by Fitnessgram counts in each group.

Contextual models also adjust for proportion of students eligible for free or reduced-price lunch and urbanization level.

Negative betas imply that higher survey scores (or Yes answers) were associated with a faster mile time (better fitness) or lower BMI z-score (better weight status).

* Interaction by grade suggested (p<0.20).

Table 4

Associations with PA opportunities by grade.

	7th grade Beta [95% CI]		9th grade Beta [95% CI]	
	Simple model	**Model w/ contextual factors**	**Simple model**	**Model w/ contextual**
		Mile Time (mins)		
School-related PA (%Yes)				
Active transport to school	−4.6 [−9.5, 0.2]	**−3.3 [−5.9, −0.7]**	−0.4 [−3.2, 2.4]	−0.6 [−2.9, 1.7]
Full-year PE Participation	−5.4 [−10.9, 0.0]	**−5.7 [−10.8, −0.6]**	−0.3 [−2.7, 2.1]	−0.2 [−2.0, 1.6]
Like PE	**−8.6 [−16.3, −0.9]**	**−5.0 [−9.2, −0.9]**	0.1 [−3.8, 4.1]	−0.7 [−2.8, 1.4]
Use of facilities (days/wk)				
PA on school grounds not during school	**−1.1 [−1.9, −0.3]**	**−1.0 [−1.8, −0.2]**	−0.2 [−1.1, 0.7]	−0.1 [−0.6, 0.3]
		BMI z-score		
School-related PA (%Yes)				
Active transport to school	0.3 [−0.5, 1.2]	−0.0 [−0.9, 0.9]	**0.9 [0.5, 1.4]**	**0.5 [0.0, 0.9]**
≥ 20 mins of PA in PE	−0.1 [−0.8, 0.5]	−0.1 [−0.6, 0.5]	**−0.7 [−1.4, −0.0]**	−0.5 [−1.2, 0.2]

All models are adjusted for sex, take clustering by school into account, and are frequency weighted by Fitnessgram counts in each group.

Contextual models also adjusted for proportion of students eligible for free or reduced-price lunch and urbanization level.