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Facility provision in elementary schools: Correlates with physical education, recess, and obesity

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Abstract

Objectives—The objectives were to: (1) document correlations among facility provision (availability and adequacy) in elementary schools, child sociodemographic factors, and school characteristics nationwide; and (2) investigate whether facility provision is associated with physical education (PE) time, recess time, and obesity trajectory.

Methods—The analytic sample included 8935 fifth graders from the Early Childhood Longitudinal Survey Kindergarten Cohort. School teachers and administrators were surveyed about facility provision, PE, and recess time in April 2004. Multivariate linear and logistic regressions that accounted for the nesting of children within schools were used.

Results—Children from disadvantaged backgrounds were more likely to attend a school with worse gymnasium and playground provision. Gymnasium availability was associated with an additional 8.3 min overall and at least an additional 25 min of PE per week for schools in humid climate zones. These figures represent 10.8 and 32.5%, respectively, of the average time spent in PE. No significant findings were obtained for gymnasium and playground adequacy in relation to PE and recess time, and facility provision in relation to obesity trajectory.

Conclusions—Poor facility provision is a potential barrier for school physical activity programs and facility provision is lower in schools that most need them: urban, high minority, and high enrollment schools.

Keywords

School; Exercise; Sports; Child; Obesity

Introduction

The role of physical activity in obesity prevention is well established, but less than half of children meet national recommendations (Troiano et al., 2008). Children spend much of their day at school and physical education (PE) and recess programs at school could reduce the gap between actual and recommended physical activity (Wechsler et al., 2000). The availability and adequacy of facilities may be a critical component in the provision of school physical activity programs (Davison et al., 2006; Sallis, 2006).

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This study documents the state of physical activity facilities in United States elementary schools and how it relates to child characteristics, school factors, PE, and recess. A number of studies suggest that neighborhood recreational facilities are associated with higher activity levels among youth and that facilities are often poorer or nonexistent in disadvantaged neighborhoods (Davison et al., 2006; Gordon-Larsen et al., 2006; Ferreira et al., 2007; Powell et al., 2006; Powell et al., 2007; Romero, 2005; Sallis et al., 2000). Schools may counter or exacerbate this neighborhood effect. We are therefore interested in whether child and school disadvantage predicts lower quality facility provision, which in turn would be associated with less time scheduled for PE and recess programs. We also investigate if the relationship between facilities and physical activity programs is modified by environmental constraints such as a climate that is not supportive of outdoor activity, or a lack of alternate facilities, such as an auditorium or multipurpose room. Finally, we assess whether quality of facilities is associated with the obesity trajectory between kindergarten and 5th grade.

Data on the relationship between school facilities and physical activity are limited. Nationwide, it was reported that 22.6% of schools did not have a gymnasium (Lee et al., 2007). In a sample of elementary schools, facility availability and equipment were associated with more physical activity opportunities in a sample of elementary schools (Barnett et al., 2006). Facility provision alone may not be supportive of higher physical activity, of course, as this also depends on supervision and instruction (Sallis et al., 2001).

Methods

The Early Childhood Longitudinal Study Kindergarten Cohort (ECLS-K)

The ECLS-K is conducted by the National Center for Educational Statistics. The base year cohort, selected based on a multistage probability design covering the United States is nationally representative of children attending kindergarten in the 1998–1999 school year. Responses are collected in each round of data collection from children, parents/guardians, teachers, school administrators, and school facility inspectors. Data from the spring of 1999 wave (corresponding to kindergarten) and the spring of 2004 (corresponding to 5th grade) were used for the analysis. Children from racial/ethnic minority groups or attending private schools were oversampled and about 50% of children who changed schools were randomly selected for follow-up. More details on the survey are available at <http://nces.ed.gov/ecls/>. Key measures are described below.

School facility measures—The school administrator (principal or headmaster) assessed the availability and adequacy of the school gymnasium, playground, multipurpose room, cafeteria, auditorium, and classroom. The gymnasium was considered to serve as the primary facility for PE while the playground was considered to be the primary facility for recess. The playground was defined as an alternate facility for PE while the gymnasium was an alternate facility for recess. For each facility the administrator was asked: “in general, how adequate is the [facility] for meeting the needs of the children in your school?” Response options included “Do not have,” “never adequate,” “often not adequate,” “sometimes not adequate,” and “always adequate.” As “do not have” and “always adequate” were the most common responses, the “never adequate,” “often not adequate,” and “sometimes not adequate” responses were collapsed into a category referred to as “inadequate” to preserve sample size. Two binary measures were constructed: (1) whether or not the school had the facility; and (2) whether or not the facility was adequate conditional on the school having the facility in question. The term “facility provision” refers to both facility availability and adequacy.

Physical education (PE) and recess time—The child's math and reading teachers reported the number of times PE and recess were held per week and the number of minutes per

session. These numbers were multiplied by each other to obtain the minutes of PE and recess time in the past week. The average value was used if both teachers responded. Responses from teachers likely reflected scheduled times for PE and recess as opposed to the actual lengths of these programs.

Childhood obesity measures—Body-mass index (BMI) was calculated from measured height and weight. ECLS-K-trained assessors collected two measures each for height and weight using a Shorr Board (Shorr Productions, Olney, MD) and a digital bathroom scale. The age- and sex-specific BMI percentile for each child was calculated using a SAS program (SAS Institute, Inc., Cary, NC) based on the updated 2000 Growth Charts (Kuzmarski, 2002; CDC, 2000). Children with a BMI exceeding the 95th percentile were classified as obese and those with a BMI between the 85th and 95th percentiles were classified as overweight. Obesity trajectory was defined as the change in BMI percentile over time.

School characteristics and other measures—The percentage of free-or-reduced lunch (FRPL) students at the school and whether or not the school received Title I funds were reported by the school administrator. Schools where 50% or more of the student body was minority were considered to be high minority while schools with at least 500 children enrolled were considered to be high enrollment. The child's parent or guardian reported on how safe it was for the child to play outside the home. This measure served as an indicator of the relative importance of having recreation facilities in the neighborhood. Household income and child race/ethnicity were reported by the parent and included as controls. School management type (private or public), census geographic region (Northeast, Midwest, South, and West), and degree of urbanization (regions which where large or mid-size cities were classified as urban, large or mid-sized suburbs, and large towns were classified as suburban and small towns and rural areas were classified as rural) were reported by the school administrator.

Climate zone—Each county in the United States is classified into one of six climate zones (refer to Fig. 1) as defined by a report commissioned to assist builders in home construction (U.S. Department of Energy Building America Program, 2007). Climate zones are defined by heating degree days (the difference between the average outdoor temperature and the room temperature), average temperatures, and precipitation. The “cold,” “very cold,” and “subarctic” zones were combined into the category “cold,” and the “hot-dry” and “mixed dry” zones were combined into the category “dry.”

Climate data were merged with ECLS-K using the school county identifiers. The final analytic sample included 8392 fifth graders in 1387 schools across the country. Of these 6777 children attended the same school in kindergarten and 5th grade and had recorded weight and height in both years.

Statistical analyses

Descriptive statistics and multivariate regression were used to analyze the correlates of facility provision, PE, recess, and obesity trajectory. Analysis of variance (ANOVA) was used to test the statistical significance of differences in facility provision by child and school factors. Logistic models were estimated when facility provision was the dependent variable while linear models were estimated when PE or recess time was the dependent variable. Facility availability and adequacy were investigated separately. If facility provision was not determined to be a significant predictor for the full sample, the analyses were repeated for subgroups of schools with an environmental constraint. These constraints included urban location, having fewer than five alternate facilities, and climate zone. It is quite plausible that there are no overall effects and that facilities only matter in combination with other environmental constraints. For example, in a mild dry climate (like Southern California), outdoor PE is possible year round

and there is much less need for an indoor facility. Similarly, multiple alternate facilities such as multipurpose rooms and cafeterias can substitute for designated gymnasiums. Child-level regressions were clustered on schools and employed robust standard errors to adjust for the sampling design of ECLS-K. Sampling weights were applied to approximate the 5th grade population. Regression results were not reported if the sample had fewer than 50 observations.

Results

Facility provision by child and school characteristics

Table 1 presents descriptive statistics of the sample by facility provision. Of schools in the 5th grade sample 67.9% had a gymnasium and that figure was significantly lower for schools that were high enrollment, high minority, located in urban areas, or had fewer than five alternate facilities ($P<0.05$). Most schools in cold and mixed-humid zones had a gymnasium as compared with 24.3% in dry climate zones and 11.1% in marine climate zones. Hispanic and Black children were less likely to have a gymnasium at school than White children (49.1 and 76.1% as compared to 82.0%). Children from low-income households and for whom it was unsafe to play outside were also less likely to attend a school with a gymnasium. No significant findings emerged for obesity or overweight status (overweight status not shown).

The gymnasium was reported to be adequate in 77.8% of schools. Differences by child and school characteristics were similar but less stark as compared with our findings regarding gymnasium availability. For example, high enrollment, high minority, and urban schools were not more likely to have an inadequate gymnasium.

As only 2.5% of schools do not have a playground, only the correlates of having an adequate as compared to an inadequate playground are displayed in Table 1. Schools with a high fraction of minority children were more likely to report an inadequate playground. Children from low-income households or from racial/ethnic minorities were also less likely to have an adequate playground at school.

Physical education and recess time by facility provision

Schools provided an average of 77 min for PE class and 38 min for recess during the past week. Table 2 shows that schools with a gymnasium provided 8.3 min more of PE per week than schools without a gymnasium after controlling for other covariates ($P<0.01$). The association is stronger for schools in humid climate zones—gymnasium availability in hot-humid regions was associated with an additional 17.4 min of PE while it was associated with an additional 25.0 min of PE in mixed-humid regions. Gymnasium adequacy was not associated with significantly more PE time, nor was playground adequacy associated with more recess time.

Schools located in dry or hot-humid zones spent 25 min more on average in PE in the past week as compared with schools in cold zones. Schools that were high minority also reported 6.3 fewer minutes of PE class ($P<0.05$). Schools in rural regions reported 11.1 min more of recess as compared to urban regions while no differences by urbanization were found for PE ($P<0.001$). Schools that were high enrollment also devoted less time to recess. The number of alternate facilities was not associated with PE or recess time.

Only the coefficient of gymnasium availability was significant for the full sample, but not the coefficients for administrator-reported gymnasium or playground adequacy. This could be because many schools were not constrained and we therefore repeated the analysis for schools with an environmental constraint. Environmental constraints included urban location, less than five alternate facilities, and climate zone. Table 3 presents these results. Gymnasium adequacy was associated with more PE time in all of the considered subgroups, but none of them were statistically significant except for schools in an urban location. For these schools, gymnasium

availability was associated with 10.3 min more of PE time ($P<0.05$). Playground adequacy was not associated with more recess time for several subgroups such as schools located in dry or hot-humid climate zones.

Obesity trajectory by facility provision

The prevalence of obesity in the sample increased from 11.8 to 20.1% between kindergarten and 5th grade and the average BMI percentile increase was 5.4 units. Gymnasium and playground provision in 5th grade were not predictive of a lower obesity or overweight trajectory both overall and for stratifications separately by gender, obesity, or overweight status in kindergarten, household poverty, region, and climate zone (results not shown). Findings did not change substantially or gain statistical significance when facility provision in kindergarten was included as a control in our models.

Discussion

We find that 26.1% of children attended a school without a gymnasium which is comparable to figures reported elsewhere (Lee et al., 2007). When there was a gymnasium, it was rated as inadequate by the administrator in one-fifth of the schools. Most children were in schools with a playground, but overall 37.3% of students had an inadequate playground at school. Low socioeconomic status children, including those from racial/ethnic minorities and low-income households, were less likely to attend a school with a gymnasium. While school facilities may represent a safe area to play for children in neighborhoods with safety concerns, we find that these children were more likely to attend schools with worse facility provision. These findings complement other studies indicating that neighborhoods with low-income and high-minority residents have less access to recreational facilities (Powell et al., 2006; Gordon-Larsen et al., 2006).

Gymnasium availability was associated with 8.3 min more of PE time per week for all schools in the sample. For schools in mixed-humid or hot-humid climate zones, however, the effect was three times as large. These figures represent 10.8 and 32.5% of the average time all children in the sample spend in PE. The sample averages of 77 min of PE and 38 min of recess per week fall short of the recommended levels of 150 min and 100 min, respectively (IOM, 2005; NASPE, 2006).

The stronger association between gymnasium availability and PE time for schools in hot-humid and mixed-humid climate zones may be due to the survey being conducted in April. Although we are unable to test this hypothesis with these data, we would expect that the association would be stronger for schools in cold climates during the winter months. That schools in hot-humid and mixed-humid zones spend more time in PE and less in recess also supports weather being a determining factor in school physical activity programs.

While gymnasium and playground adequacy were not found to be related to PE and recess time for the overall sample, gymnasium adequacy was found to be associated with PE time for schools in urban locations. As space is at a higher premium for urban schools, adequacy may refer to the capacity of the facility in relation to class sizes. Statistically significant findings were not obtained for other environmental constraints as we had hypothesized.

Facility provision is not a significant predictor of obesity trajectory, although we found gymnasium provision to be associated with more PE time. But the amount of extra PE would be a very small part of overall energy expenditure even if children were active, so seeing a significant association would have been unusual. Our measure of PE time is more likely to be scheduled as opposed to actual time, let alone active time. Facilities may shape the curriculum and quality of PE class, but no information regarding how time is spent is collected in the

survey. Our analysis also does not consider factors such as dietary intake that may also be implicit in obesity trajectory.

Important Study Limitations

School administrators were asked about physical activity programs in the previous week, not over the course of a year, and their responses were collected in the spring. Our measures of facility provision were reported by the school administrator and not validated by an outside source. School administrators may have demonstrated a reluctance to report that facilities were inadequate or may have exaggerated their inadequacy in order to procure more funds for renovations. The latter bias may explain our findings that lower SES schools have worse facility provision. No information regarding the brand and model of the scales used to measure child weight was included in the ECLS-K documentation. This limited our ability to investigate if calibration may have affected the validity of the measurements taken. Lastly, we are unable to determine if the schools provided after-school programs or had established community partnerships even though studies suggest that these might be important policies for increasing children's engagement in physical activity (CDC, 2008; Mota et al., 2003; Trost et al., 2008). After-school or weekend access to school gymnasiums and playgrounds may be particularly important for children from neighborhoods that lack green space or recreational facilities.

Conclusions

We found differences in facility provision by sociodemographic characteristics and that gymnasium availability was associated with more PE time particularly for schools in mixed- and hot-humid climate zones. Insights into how school facilities shape physical activity programs and child physical activity levels could support the development of appropriate recommendations and interventions.

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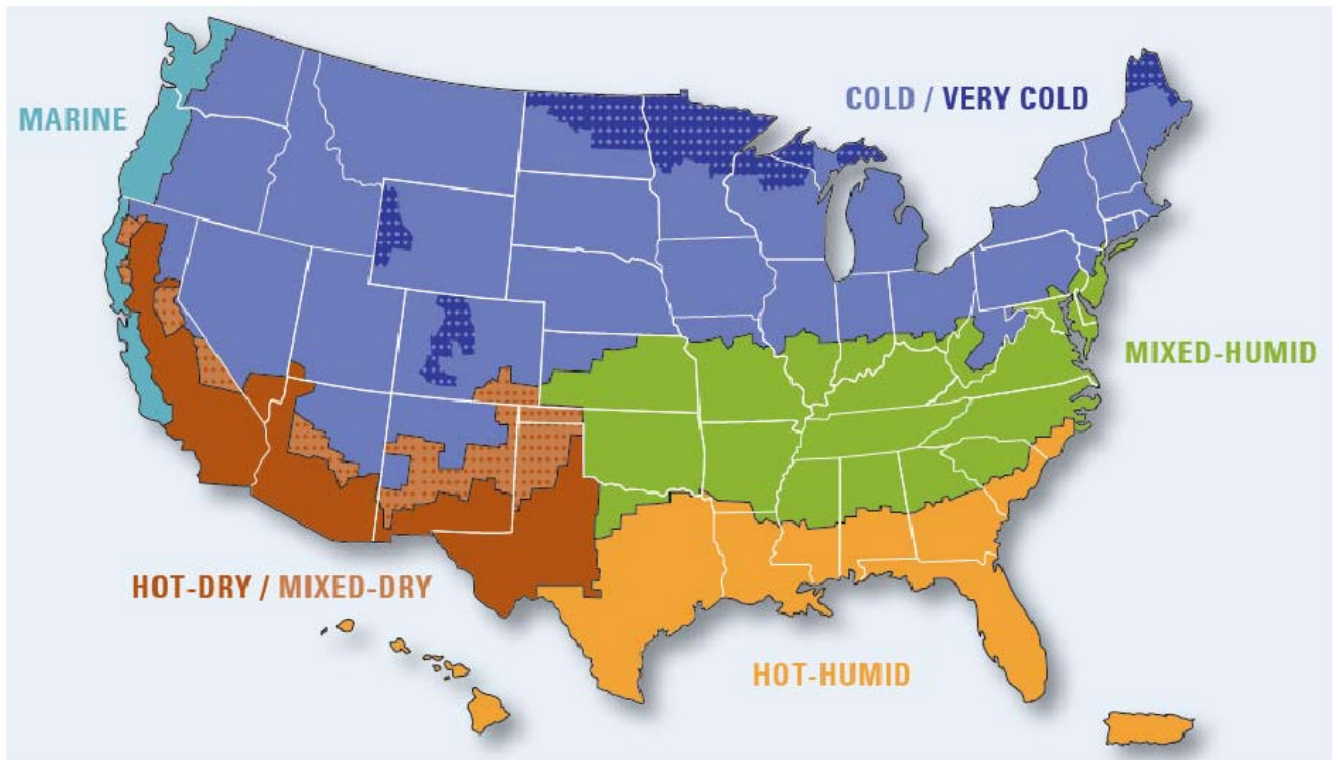


Fig. 1. Climate zones recognized by *Building America*. Reproduced with permission from: *Building America Best Practices: Series for High-Performance Technologies: Determining Climate Regions*, December 2007.

Table 1
Gymnasium and playground provision by child and school characteristics (ECLS-K).^a

	Gymnasium available			Gymnasium adequate ^b			Playground adequate ^c		
	<i>n</i>	Mean	95% CI	<i>n</i>	Mean	95% CI	<i>n</i>	Mean	95% CI
Child level									
Race/ethnicity									
White	4,983	82.0	(81.0, 83.1)	4,056	80.2	(78.9, 81.4)	4,899	66.1	(64.8, 67.4)
Black	897	76.1	(73.3, 78.9)	693	74.5	(71.3, 77.8)	845	54.8	(51.4, 58.2)
Hispanic	1,450	49.1	(46.5, 51.7)	710	80.1	(77.1, 83.0)	1,405	58.7	(56.2, 61.3)
Other ^d	1,062	69.6	(66.9, 72.4)	619	67.1	(63.4, 70.8)	1,114	62.1	(59.1, 65.1)
Household income (456 unknown) ^e									
\$25,000 or less	1,700	70.0	(67.7, 72.1)	1,146	76.0	(73.5, 78.4)	1,633	57.7	(55.3, 60.1)
More than \$25,000	6,236	76.0	(74.9, 77.0)	4,634	79.6	(78.5, 80.8)	6,101	64.5	(63.3, 65.7)
Obesity status ^f									
Not obese	6,679	73.8	(72.8, 74.9)	4,823	78.1	(77.0, 79.3)	6,518	62.6	(61.5, 63.8)
Obese	1,713	74.1	(72.0, 76.2)	1,255	79.2	(76.9, 81.4)	1,658	63.1	(60.8, 65.4)
Safety around home (628 unknown) ^g									
Not safe or somewhat safe	1,799	67.2	(65.1, 69.4)	1,140	74.3	(71.8, 76.8)	1,720	56.0	(53.6, 58.3)
Very safe	5,965	77.2	(76.2, 78.3)	4,529	80.0	(78.9, 81.2)	5,848	65.3	(64.0, 66.5)
Overall	8,392	73.9	(73.0, 74.8)	6,078	78.3	(77.3, 79.4)	8,176	62.7	(61.7, 63.8)
School level									
School enrollment									
<500 children	776	75.5	(72.5, 78.5)	586	76.6	(73.2, 80.1)	758	60.4	(56.9, 63.9)
>500 children	611	58.3	(54.3, 62.2)	356	79.8	(75.6, 84.0)	595	61.3	(57.4, 65.3)
Minority									
<50%	789	78.1	(75.2, 81.0)	616	79.1	(75.8, 82.3)	779	65.6	(62.3, 68.9)
>50%	598	54.5	(50.5, 58.5)	326	75.4	(70.8, 80.2)	574	54.4	(50.3, 58.4)
Number of facility alternates ^h									
Less than five	1,161	65.9	(63.2, 68.6)	765	77.6	(74.7, 80.6)	1,176	59.7	(56.9, 62.5)
Has five	226	78.3	(72.9, 83.7)	177	78.5	(72.4, 84.6)	177	68.3	(61.4, 75.3)

	Gymnasium available			Gymnasium adequate ^b			Playground adequate ^c		
	<i>n</i>	Mean	95% CI	<i>n</i>	Mean	95% CI	<i>n</i>	Mean	95% CI
Degree of urbanization ^f									
Urban	646	60.4	(56.6, 64.2)	390	78.7	(74.6, 82.8)	625	59.2	(55.3, 63.1)
Suburban	525	70.5	(66.6, 74.4)	370	78.6	(74.5, 82.8)	518	62.7	(58.6, 66.9)
Rural	216	84.3	(79.4, 89.2)	182	74.2	(67.8, 80.6)	210	61.0	(54.3, 67.6)
Climate zone (29 unknown) ^g									
Cold	515	88.3	(85.6, 91.1)	455	77.4	(73.5, 81.2)	500	61.0	(56.7, 65.3)
Dry	255	24.3	(19.0, 29.6)	62	66.1	(54.0, 78.2)	252	54.4	(48.2, 60.6)
Hot-humid	210	45.7	(38.9, 52.5)	96	84.4	(77.0, 91.8)	206	66.0	(59.5, 72.5)
Marine	36	11.1	(0.3, 21.9)	4	—	—	36	—	—
Mixed-humid	342	90.4	(87.4, 93.5)	309	79.3	(74.7, 83.8)	331	61.3	(56.1, 66.6)
Overall	1,387	67.9	(65.5, 70.4)	942	77.8	(75.2, 80.5)	1,353	60.8	(58.2, 63.4)

^aAll analyses are univariate. Values at the child level are weighted; values at the school level are not weighted.

^bConditional on the school having a gymnasium.

^cConditional on the school having a playground.

^dIncludes Native Hawaiians, Pacific Islanders, American Indians, Alaskan Natives, and multirace non-Hispanics.

^eReported by the child's parent or guardian.

^fA child is obese if the BMI exceeds the 95th age- and sex-specific BMI percentile.

^gReported by the child's parent or guardian.

^hFacilities that could serve as a substitute for a gymnasium or playground include multi-purpose rooms, cafeterias, classrooms, and auditoriums. A playground was counted as a substitute for a gymnasium and a gymnasium was counted as a substitute for a playground.

ⁱRural refers to small towns, suburban refers to large and mid-size suburbs, and large towns and urban refers to large and mid-size cities.

^jRefer to Fig. 1 for definition.

Table 2
 Association between facility provision and minutes of physical education and recess time per week.^a

	Physical education time (min)		Recess time (min)	
	Coeff	(SE)	Coeff	(SE)
Facility provision				
Gymnasium available	8.29	(3.79)**		
Gymnasium available and adequate	3.04	(3.05)		
Playground available and adequate			-1.41	(1.85)
Number of alternates	-1.00	(1.41)	-1.05	(1.01)
Climate zone (Ref=cold) ^b				
Dry	36.50	(5.95)***	-1.46	(2.92)
Hot-humid	27.29	(5.98)***	-21.43	(2.40)***
Marine	9.16	(7.50)	2.13	(5.76)
Mixed-humid	30.57	(10.19)**	-12.45	(2.20)***
Interactions between facility provision and climate zone ^c				
Dry* <i>gym</i> available	8.92	(9.97)	-	-
Hot-humid* <i>gym</i> available	17.40	(8.25)*	-	-
Marine* <i>gym</i> available	14.22	(25.55)	-	-
Mixed-humid * <i>gym</i> available	24.96	(10.53)*	-	-
School characteristics				
High enrollment ^d	1.22	(2.81)	-4.37	(1.84)*
Private	-2.24	(3.19)	0.06	(3.27)
Title I receipt	-0.72	(2.47)	-0.18	(2.16)
High minority ^e	-6.28	(2.80)**	-1.72	(2.35)
Urbanization (Ref=urban) ^f				
Suburban	-2.19	(2.89)	1.41	(2.09)
Rural	2.94	(3.45)	11.05	(3.10)***
Constant	62.87	(6.57)***	57.00	(5.04)***
Schools, <i>n</i>	1,358		1,325	

^a * *P*<0.05; ** *P*<0.01; *** *P*<0.0001.

- ^b Refer to Fig. 1 for definition.
- ^c Interactions for models where gymnasium adequacy and playground adequacy served as the dependent variables were not included because the main effects were not statistically significant.
- ^d School has 500 or more students.
- ^e School has 50% or higher minority students.
- ^f Rural refers to small towns, suburban refers to large and mid-size suburbs, and large towns and urban refers to large and mid-size cities.

