



The Association of Rural Elementary School Environmental Characteristics with Children's Physical Activity Levels at School

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Abstract

Background: The importance of school settings for obesity prevention efforts may be most critical in low-income rural areas where healthy eating and physical activity (PA) resources are scarce. This study examined the association of rural elementary school environmental characteristics with children's PA behaviors at school.

Methods: Analyses were based on objectively measured height, weight, and PA data from 1443 first to sixth graders attending six rural elementary schools in Oregon. The School Physical Activity and Nutrition Environment Tool (SPAN-ET) was used to measure elementary school PA policy, practice, and physical environments. Multivariable linear regressions were used to examine associations of 29 SPAN-ET PA measurement criteria, with total PA (light, moderate, vigorous; min/d), and moderate-to-vigorous PA (MVPA; min/d), adjusting for child sex, age, and BMI z-score.

Results: Our final sample included 755 boys and 688 girls (9 ± 1.7 years); Of them, 16% were overweight and 21% obese. Total PA was positively associated with 21 SPAN-ET PA criteria (unadjusted P value ranged from 0.7 to 0.001; adjusted $P < 0.0125$); 15 criteria were positively associated with MVPA (unadjusted P value ranged from 0.313 to 0.001; adjusted $P < 0.00625$).

Conclusions: Characteristics of rural school environments are associated with children's PA behaviors at school. Structured physical education, classroom-based PA, PA messaging, and adequate indoor/outdoor space are important correlates of PA in rural schools.

Keywords: Obesity Prevention, Physical Activity, School Environments

1. Background

Childhood obesity prevention is a public health priority in the U.S. (1-3). Obese youth are at increased risk for cardiovascular disease, type 2 diabetes, stroke, some cancers, poor psychosocial health outcomes, and early mortality (4-7). Schools can play a critical role in obesity prevention, as more than 95% of U.S. youths (ages 5 - 17) are enrolled in school (8). Youth spend, on average, 6.64 hours/day over 180 days at school each year, and this signifies the influence of school environments on children's health (9). In rural areas where community resources for healthy eating and physical activity (PA) may be scarce, schools provide a critical venue for obesity prevention (10). We have previously observed that rural children accrue low levels of PA at school and that the amount of PA rural children attain at school is inversely associated with their body mass index (BMI) (11). This highlights the importance of identifying specific environmental factors (policies, practices,

physical characteristics) in rural school settings that are associated with children's PA at school. Doing so will enable rural schools to better target intervention strategies and improve obesity prevention efforts.

The purpose of this study was to examine the association of school PA environmental characteristics (i.e., policies, practices, physical environment) with objectively measured PA of children in six rural elementary schools in Oregon.

2. Methods

2.1. Participants and Settings

This study was conducted as part of a larger collaborative research effort funded by the United States Department of Agriculture examining the influence of rural community, school, and family home environments on children's weight-health (12). The larger study was a

community-campus health partnership between Oregon State University Public Health Extension (OSUPHE) and six rural community schools in Oregon, located in three Oregon counties. School eligibility criteria were determined as rural schools (13) within the targeted counties having > 48% of enrolled students eligible for free or reduced lunch. The sample was stratified by county and eligible schools within each targeted county were randomly selected to participate. If the selected school declined the invitation to participate, another school was selected. This process continued until two schools were selected within each targeted county. Families were informed about the study through school communications and provided the opportunity to opt children out of any or all assessments. The study was reviewed and approved by the OSU institutional review board.

2.2. Instruments and Procedures

2.2.1. School Environment Assessments

The School Physical Activity and Nutrition Environment Tool (SPAN-ET) is a comprehensive environmental assessment developed as a research and practice-based assessment-to-action tool (14). SPAN-ET can be used to measure 16 PA environment characteristics through the evaluation of 106 specific criteria and 11 nutrition environment characteristics via evaluation of 81 criteria. The data collected using SPAN-ET provides documentation of regulatory components such as the size of gymnasium and lunchroom spaces relative to building codes in the U.S., and documentation about policies, practices, and environmental features that evidence suggests may have a direct impact on children's diet and PA behaviors at school. As such, the scope of assessment includes criteria proven to influence PA behaviors (e.g., recess policies, PE) as well as criteria related to regulatory compliance and landscaping (i.e., the height of a gymnasium ceiling, variety of tree species) that may be important for school practitioners to capture, but less relevant for research purposes. For this study, we excluded regulatory and landscaping criteria and focused on a subset of criteria shown to influence PA behaviors that children would be exposed to during school hours.

SPAN-ET data were collected by trained OSUPHE researchers between January 28th and March 7th, 2014 at each of the six participating schools. The process spanned approximately 1 to 2 weeks in each school. SPAN-ET data collection processes involved document review (e.g., wellness policies, school menus, curricula), key personnel interviews (e.g., principals, PE teachers, meal service staff), direct observations of physical features (e.g., playground, fields, cafeteria), and behavioral situations (e.g., recess, lunch, physical education (PE)). SPAN-ET assessments were

scored using a process of evaluating whether specific criteria across a variety of PA and nutrition categories were determined to be "met" or "unmet". Complete SPAN-ET assessment and scoring procedures are described in detail elsewhere (14).

2.2.2. Child Physical Activity Assessment

Physical activity was measured on four consecutive days during school hours between September 22nd and November 7th, 2014. Our aim was to collect data on all children at each school. On day one, classroom teachers were trained to distribute pedometers, track non-compliance, wear time (min/day), and school attendance, and to help children put on the pedometers at the start of each school day and remove them at the end of the school day. Children wore the pedometers on their right hip, attached by an elastic belt. Researchers collected devices at the end of each school day and prepared them for distribution by teachers the subsequent day. We used Walk4Life MVP pedometers (Walk4Life Inc.; Oswego, IL), a validated device that records light, moderate and vigorous PA, and enables partitioning of moderate to vigorous physical activity (MVPA) from total activity by differentiating activity minutes at or above a prespecified step rate. To characterize MVPA in this study, we applied a cut point of > 120 steps/min based on the work of Graser et al. (15) and Beets et al. (16).

Pedometer data were downloaded on the last day of data collection (day 4) along with child-specific daily wear time, attendance, and compliance data. Minutes of PA attributable to pedometer transport by researchers was derived for each pedometer and subtracted from each child's PA data. Mean minutes per day were calculated based on total PA minutes accrued in each category (Total PA, MVPA) divided by wear time.

2.2.3. Body Mass Index (BMI) Assessment

Height and weight were measured concurrently with PA over two days at each school by OSUPHE trained research assistants. Height was measured to the nearest 1.0 mm using seca model 213 portable stadiometers, and weight was measured to the nearest 0.1 kg using seca model 806 portable digital scales (seca, Inc.; Chino, CA). Children removed shoes, hats, and hair accessories prior to measurement. Height and weight data were used to calculate BMI (kg/m^2) values for each child. Raw BMI data were transformed to BMI z-scores based on the centers for disease control and prevention (CDC) growth charts (17). Children were classified as overweight or obese using the age- and sex-specific 85th and 95th percentiles from the CDC growth charts (18).

2.3. Data Analyses

To obtain the specific subset of SPAN-ET criteria for analyses, we took the following steps. First, we excluded regulatory-related criteria (e.g., gym ceiling height, quality of school ground fencing, etc.; $n = 62$). Next, since objective PA data were collected during school hours, we excluded criteria addressing before or after school PA contextual factors (e.g., walk/bike to school supports, after-school program indicators, etc.; $n = 9$). We also excluded criteria for which there was no variability across the six schools (i.e., all six schools either met or did not meet the criterion; $n = 6$), and one criterion for which there was missing data across multiple schools. Remaining SPAN-ET criteria were reorganized into one of the three thematic categories promoting students' PA during regular school hours: 1, structured physical education (PE); 2, classroom-based physical activity (CBPA); and 3, recess (19). In total, 29 criteria were included in the analyses.

For each SPAN-ET criterion included in the analyses, children were divided into two groups based on whether they attended a school that met or did not meet the specifications of the criterion. For example, "The school has a trained and credentialed PE teacher." is one criterion in the PE category. All children attending a school that met this criterion fell into one group (MET), and children attending a school that did not meet this criterion fell into a second group (UNMET). We examined each criterion one at a time using the process of grouping children into MET or UNMET groups. Multivariable linear regression was used to examine the associations between children's activity levels (total PA and MVPA; i.e., outcomes) and each SPAN-ET criterion (i.e., exposure). Age, sex, and BMI z-score were included as covariables in each regression model to adjust for their potential influence on child PA behavior. A regression model was computed for each SPAN-ET criterion independently; therefore, it was necessary to adjust for multiple comparisons which was done using the Hochberg procedure (20). The corrected overall critical P value for total PA was $P < 0.0125$ and the critical P value for MVPA was $P < 0.00625$.

3. Results

Table 1 demonstrates the descriptive characteristics for the six schools that participated in the study as well as the child-level, age, sex, BMI, and PA data. We measured 1595 of 1923 enrolled first to six graders (82.9%). Children did not participate in the assessment for the following reasons: 34 were absent on data collection days, 44 dropped out of school before assessment, 134 opted out of participation, and 119 lost their pedometer. The final sample included

1443 children (90.5% of measured children; 755 boys and 688 girls), with valid PA and BMI data (BMI z-scores data < 4 SD for sex and age and > 3 valid PA monitoring days). Mean age of participants was 9 ± 1.7 years. Based on BMI percentile, approximately 62% were normal weight, 16% overweight, and 21% obese. On average, children wore pedometers for 6.0 ± 0.4 hours per day. The average participation in MVPA and total PA was 18.4 ± 9.1 and 47.3 ± 19.0 minutes per day, respectively. Boys accrued more total PA and MVPA compared to girls ($P < 0.001$). Specifically, boys accumulated 19.7 ± 9.7 min/d of MVPA and 50.9 ± 19.2 min/d of total PA, whereas girls accumulated 16.9 ± 8.0 min/d of MVPA and 43.5 ± 18.0 of total PA, respectively.

Table 2 displays the results of separate multivariable linear regression models examining the associations between each analyzed SPAN-ET criterion with total PA and MVPA. Children engaged in significantly more minutes of total PA and MVPA in schools that met certain SPAN-ET criteria. For example, in schools where the criterion "Classroom teachers include 3- to 5-minute breaks for fun and creative PA during class." was scored as "met", children engaged in an average of 8.4 ± 1.3 more min/d of total PA and 3.8 ± 0.6 more min/d of MVPA compared to children in the schools where this criterion was scored as "unmet". Overall, total PA was positively associated with 19 of 29 analyzed SPAN-ET PA items (adjusted $P < 0.0125$), and 15 items were positively associated with MVPA (adjusted $P < 0.00625$).

4. Discussion

This study examined the association of rural school PA environmental characteristics as measured by the SPAN-ET, with children's objectively measured PA accrued during regular school hours. Of particular interest, this was the first study to examine environmental characteristics of rural elementary schools in relation to PA levels of rural children at school.

The data collected showed all criteria related to PE policies (e.g., students participate in at least 150 minutes per week of structured PE) and practices (e.g., PE instructors actively participate in PE activities) were positively associated with total activity. Having gym space dedicated to PE, which is reflective of policies that support PE programming and physical environment supports, was also positively associated with total PA. All but one PE criterion were also positively associated with MVPA. Meeting PE criteria was associated with between 4.0 min/d and 7.8 min/d more total activity and between 1.5 min/d and 2.9 min/d more MVPA among our sample of children. The PE criterion associated with the greatest MVPA was "Students participate in at least 150 minutes of structured PE per week."

Table 1. Characteristics of Rural Elementary Schools and School-Age Children^a

Characteristic	School 1 (N = 301)	School 2 (N = 227)	School 3 (N = 305)	School 4 (N = 364)	School 5 (N = 100)	School 6 (N = 146)	Total (N = 1443)
School Level^b							
Student enrollment	462	335	447	599	137	206	-
Students eligible for free/reduced school meals, No. (%)	275 (60)	206 (62)	329 (74)	328 (55)	119 (87)	150 (73)	-
Race/ethnicity, No. (%)							
White	405 (88)	271 (81)	270 (60)	493 (82)	43 (31)	143 (69)	-
Hispanic	28 (6)	24 (7)	151 (34)	60 (10)	6 (4)	47 (23)	-
Other	29 (6)	40 (12)	26 (6)	46 (8)	88 (64)	16 (8)	-
Child Level							
Age y	9.1 ± 1.8	9.4 ± 1.9	8.5 ± 1.4	9.0 ± 1.7	9.3 ± 1.8	9.1 ± 1.8	9.0 ± 1.7
Sex, %							
Female	48.5	48.0	50.5	44.0	49.0	50.0	52.3
Male	51.5	52.0	49.5	56.0	51.0	50.0	47.7
BMI percentile	67.0 ± 27.1	66.3 ± 26.7	67.4 ± 29.0	68.0 ± 26.5	72.7 ± 29.7	69.1 ± 26.1	67.8 ± 27.4
Physical activity (minutes/day), %							
Normal weight, %	65.5	64.8	59.3	63.5	49.0	61.0	62.0
Over-weight, %	13.0	18.9	13.8	15.7	15.0	19.2	15.5
Obese, %	20.6	15.9	24.3	19.8	35.0	18.5	21.2
Physical activity (minutes/day), %							
Total PA ^c	46.1 ± 18.5	46.0 ± 19.7	42.4 ± 14.4	48.8 ± 17.6	54.5 ± 27.5	53.8 ± 20.2	47.3 ± 19.0
MVPA ^d	16.4 ± 8.3	17.8 ± 9.0	17.3 ± 8.1	19.2 ± 9.2	20.6 ± 10.7	21.6 ± 9.6	18.3 ± 9.0

^aValues are expressed as mean ± SD or No. (%) or percentage.

^bOregon department of education (<http://www.ode.state.or.us/search/page/?id=5487>) Data reflect 2014-2015 enrollment information.

^cTotal PA = average total minutes of physical activity at school (includes light, moderate, and vigorous).

^dMVPA = average minutes of moderate and vigorous physical activity at school at a step count above 120 steps/min.

Additionally, our data showed that when the SPAN-ET criterion “PE curricula align with state and national standards.” was met, children accrued 5.3 min/d more total PA and 1.5 min/d more MVPA than if this criterion was not met. This is also consistent with data from Bassett et al., who found that when schools implemented standardized PE, students gained 6 minutes more of MVPA per day compared to non-standardized PE approaches (19). This is an important finding that confirms the importance of aligning with PE best practice recommendations (19, 21).

A finding of particular interest in our study was that when criteria related to school policies and practices encouraging classroom teachers to include 3- to 5-minute

PA breaks were met, this was associated with 8.36 min/d more total activity and 3.81 min/d more MVPA among children than when these criteria were not met. For rural elementary schools where funding for regular PE programming is often limited (22, 23), classroom teachers may be tasked with providing opportunities for children to be physically active. Our data suggest this practice is associated with higher activity levels. This has implications for practice-based recommendations in under-resourced rural school settings, as classroom-based PA breaks are likely among the more accessible and affordable evidence-based PA promotion strategies. Other factors associated with rural children receiving more PA at school include having

adequate indoor and outdoor space and equipment to accommodate PA in all weather conditions and having visible promotional materials with PA messaging throughout the school environment.

We did not observe associations between any of the recess-specific policy or practice variables and children's PA at school. In all schools, recess was a time for free play and was unstructured. It is possible that children attending these rural schools are less active at unstructured recess compared to structured PE and teacher-led classroom activity breaks. There are few studies comparing PA at recess between structured and unstructured conditions. Evidence indicates that in urban elementary school settings, when recess is unstructured, children are less active than when recess is semi-structured or structured (24). Other evidence shows that structured recess in preschool settings also translates to greater PA compared to free play (25, 26). Social scientists argue that many children are inhibited to play freely if recess feels unsafe and adding structure can lead to greater activity, particularly among vulnerable children (27). It is apparent that more research is needed to understand the influence of structured versus unstructured recess on PA in rural elementary school settings.

Finally, we observed that four criteria were negatively associated with total PA and MVPA. Two examples, having a "written wellness policy that minimally meets the district policy and includes physical activity" and "outdoor activity areas are free of safety hazards such as glass, debris, water, random stumps or exposed concrete" provoke a thought that the multi-faceted nature of the criteria made them difficult to score as the other negatively associated criteria were also multi-component.

4.1. Limitations

Although we had an adequate sample of children, our study was limited by the small sample of schools. Given that each SPAN-ET variable is the same for each child in a given school, there is limited variability to investigate deeper with our current data to examine the independent effects of each significant SPAN-ET variable. The small sample of schools also resulted in several criteria for which there was no variability across the six schools (All schools either universally met or did not meet the criterion.). It is possible that among those criteria, there are additional important environmental contributors to children's PA that we were unable to examine. It is also important to remind readers; that we did not observe children's PA in direct association with each measured environmental criterion. We did, however, measure over four consecutive school days in an attempt to capture most, if not all, of the typical programming that might have been associated with PA.

However, we do not know how active students were in PE versus recess on the days we measured.

That said, this is the first study to examine the SPAN-ET in association with PA behaviors and provides important information about the instrument. The criteria included in the SPAN-ET are based on best practice evidence and regulatory requirements (14) for school environments, but there are limited data on the instrument's predictive validity. It became clear through this process that multi-component criteria are difficult to score and difficult to interpret. As a result of this process we are working to improve the SPAN-ET.

4.2. Conclusions

The study findings highlighted important implications for PA promotion in rural elementary school settings. This was also the first time that the SPAN-ET has been associated with PA assessments to provide evidence about which school environmental components may have the greatest influence on rural children's PA behaviors at school. We confirmed that schools are important settings for PA promotion and learned that in rural elementary school settings, advocating for regular, high quality PE may be among the most important features that rural school stakeholders should consider to provide sufficient PA for obesity prevention.

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Table 2. Multivariable Linear Regression Examining Cross-Sectional Associations Between the SPAN-ET and PA Among Rural Elementary School-Age Children (N = 1443)^{a,b,c}

SPAN-ET Criteria by PA Category (Listed by primary category with Notation Denoting Additional Categories Where Applicable)	Total PA			MVPA		
	β Coef	P*	P-adj**	β Coef	P Value	P-adj
Environmental characteristics related to physical education (PE)						
1- School has a trained/credentialed PE Teacher.	5.33	0.001	0.003	1.46	0.002	0.005
2- Students participate in at least 150 minutes of structured PE per week.	7.80	0.001	0.005	2.87	0.001	0.004
3- PE instruction is based on a written and sequential PE curriculum consistent with state/national standards.	5.33	0.001	0.003	1.46	0.002	0.005
4- PE requirements are not waived for other activities or classes.	5.38	0.001	0.002	2.85	0.001	0.002
5- PA mastery skills are assessed and results appear on the report card.	4.02	0.001	0.000	0.65	0.175	0.016
6- PE promotes physically active recreation and active lifestyle skill development (e.g. jogging, bicycling, hiking, skiing).	6.53	0.001	0.002	1.86	0.001	0.003
7- Instructors actively participate in and supervise PE.	6.53	0.001	0.002	1.86	0.001	0.003
8- PE encourages pro social behaviors and active lifestyle habits.	6.53	0.001	0.003	1.86	0.001	0.004
9- The school has a dedicated facility for PE programs with adequate space to support motor development, learning, and equipment storage.	8.36	0.001	0.002	3.81	0.001	0.002
Environmental characteristics related to PE and recess						
10- Hard surface and designated field space, separate from recess spaces are available for physical education. AOI2F	-4.61	0.001	0.003	-2.30	0.001	0.003
11- Equipment storage space is available and adequate for safe and proper equipment storage and distribution.	4.02	0.001	0.005	0.65	0.175	0.012
12- Playing fields are regularly maintained.	5.33	0.001	0.002	1.46	0.002	0.002
13- Facilities are safe and accessible, including playgrounds, fields and surfaced areas (meet ADA and OSHA standards)	2.51	0.01	0.011	1.35	0.003	0.003
14- Outdoor space provides enough protection from heat and sun to accommodate the total number of student.	-8.36	0.001	0.002	-3.81	0.001	0.002
15- Outdoor activity space includes all of the following: large multipurpose solid surface; play courts; open green/field/turf space; anchored play/sport equipment; track/trail, other.	-4.25	0.001	0.004	-2.36	0.001	0.002
16- Outdoor activity space is of adequate size and shelter to accommodate the total number of students using the space during inclement weather seasons and easily accessible to indoor facilities.	2.99	0.002	0.010	0.63	0.178	0.025
17- Outdoor activity areas are free of safety hazards such as glass, debris, water, random stumps or exposed concrete.	-4.61	0.001	0.000	-2.30	0.001	0.003
18- Adequate quantity and variety of equipment is available for the number of students and students' various levels of physical abilities/interests.	4.25	0.001	0.004	2.36	0.001	0.003
19- Adult and peer role models facilitate and promote inclusive activities.	-0.38	0.70	0.050	0.98	0.037	0.010
20- Indoor space is adequate and available when outdoor conditions are unsuitable or unsafe.	7.44	0.001	0.003	3.88	0.001	0.002
21- Size of indoor space is adequate to support safe movement activities (approximately 70'x100' feet; ceiling height minimum of 20'; at least 110 sq. ft. per student user per class).	3.14	0.001	0.008	0.47	0.313	0.050
22- Restrooms and drinking fountains are located in close proximity to activity spaces.	-8.36	0.001	0.002	-3.81	0.001	0.001
Environmental characteristics related to recess						
23- Trained facilitator(s) (paid staff and/or volunteer) is/are available during recess to motivate equipment use/active participation among all students.	0.49	0.63	0.017	1.01	0.035	0.007
24- All students participate in at least 20 minutes of active (rather than sedentary/seat-based) recess daily. Some recess time is scheduled before lunch.	0.49	0.63	0.025	1.01	0.035	0.008
Environmental Characteristics Related to PE, Recess and Classroom-based PA						
25- Physical activity is not used for or withheld as punishment for students' behavior.	1.57	0.16	0.008	0.99	0.063	0.006
26- All materials and equipment are developmentally appropriate for all student ages and abilities.	3.65	0.001	0.007	1.70	0.001	0.003
27- Promotional materials strategically placed encourage physical activity.	8.36	0.001	0.002	3.81	0.001	0.001
Environmental characteristics related classroom-based PA (CBPA)						
28- Classroom teachers include 3-5 minute breaks for fun and creative physical activity during school hours. (CBPA)	8.36	0.001	0.002	3.81	0.001	0.002
Environmental characteristics related to PE, recess, and CBPA						
29- The school has a written wellness policy the minimally meets the district policy and it includes a physical activity component.	-6.04	0.001	0.002	-2.97	0.001	0.002