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Policies and characteristics of the preschool environment and physical activity of young children

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Abstract

Objectives—The preschools that children attend influence their physical activity level. But, little is known about which characteristics of a preschool may influence the physical activity of children. The purpose of this study was to examine policies and characteristics of preschools and the extent to which they influence the physical activity of 3- to 5-year-old children during the preschool day.

Methods—A total of 299 children from 20 preschools wore ActiGraph (Pensacola, FL) accelerometers an average of 8.1 hours (SD=1.5) per day for 5.5 days (SD=2.1). A researcher completed the Early Childhood Environment Rating Scale-Revised Edition (ECERS-R) for each preschool to assess quality. Classrooms and playgrounds were measured, and the preschool director was interviewed about physical activity policies. For each policy or characteristic, preschools were divided into two groups based on whether or not the characteristic/policy was presumed to promote physical activity (PPA) or not promote physical activity (NPA).

Results—Children spent fewer minutes per hour in sedentary activity and more minutes per hour in moderate-to-vigorous physical activity (MVPA) in preschools that had higher quality scores, less fixed playground equipment, more portable playground equipment, lower electronic media use, and larger playgrounds. Five preschools had all five of these characteristics, and children in those preschools had significantly higher MVPA minutes per hour and lower sedentary minutes per hour compared to children in the other preschools.

Conclusions—All preschools can encourage physical activity by providing inexpensive portable playground equipment, limiting the number of children using fixed equipment and the number of children on the playground at one time, and limiting electronic media use. Children in the top five physical activity promoting preschools accumulated more than 60 minutes per day of MVPA as compared to the children in the other preschools who accumulated less than 60 minutes per day of MVPA.

Keywords

children; preschool; childcare; physical activity; accelerometer

Experts have concluded that children 3 to 5 years of age should participate in both free play and structured physical activity. The National Association for Sport and Physical Education¹ recommends that preschoolers accumulate at least 60 minutes of structured physical activity and at least 60 minutes of unstructured physical activity daily. More than 60% of U.S. children ages 6 and under who are not yet in kindergarten are in some form of childcare or preschool.² Time spent in preschool may be one place for young children to obtain a significant portion of their daily physical activity.

Recently, Oliver and colleagues³ reviewed 49 studies of physical activity in young children. They concluded that preschool-age children spend very little time in vigorous physical activity and that the majority of their time is spent in inactivity. In one study, in which children wore accelerometers while in preschool, 3- to 5-year-old children spent an average of 42 minutes per hour in sedentary activity and only 7.7 minutes per hour in moderate-to-vigorous physical activity.⁴

There is some evidence that the preschool a child attends influences his or her level of physical activity.^{4,5} Two studies used observational methods to identify characteristics of preschools and the physical activity levels of children who attended the preschools.^{6,7} One study involved nine preschools and collected physical activity and contextual data on individual children in different settings and different times of the school day.⁶ The second involved 20 preschools and collected data on small groups of children in different settings and at different times.⁷ But no studies to date have examined preschool factors in relationship to children's activity levels across the entire school day and in a large number of preschools. The purpose of the present study was to examine policies and characteristics of preschools that may influence the time children spend in physical activity and sedentary behaviors. This study included twenty preschools, and children wore accelerometers to measure physical activity during the preschool day.

Methods

Study Design and Participants

Participants in this study were enrolled in the Children's Activity and Movement in Preschool Study (CHAMPS). All 3- to 5-year-old children from preschools (n=24) enrolled in the study were asked to participate. Three types of preschools, commercial, faith-based, and federally-supported Head Start programs, were included in the study. For the analyses presented in this paper, accelerometer data from two preschools were unusable and two of the preschools were excluded due to lack of information about the time of children's arrival at and departure from school. Of the 20 preschools included in the accelerometer analyses, 11 were commercial, 6 were faith-based, and 3 were Head Start programs. Data were collected at each preschool during two data collection waves of two weeks duration each, separated by 13 to 19 months. After deletions for missing data for age (n=4), accelerometer data for 299 children were available for analysis. Written informed consent was obtained from each child's parent or guardian prior

to collection of data. The study was approved by the University of South Carolina Institutional Review Board.

Director Interview

A structured interview was conducted by a member of the research team with an administrator in each preschool. The interview was designed to determine the physical activity and sedentary activity policies and practices of the preschools.⁶ The interview was composed of questions that allowed the interviewer to probe for further detail (such as number of times per day or week).

For each policy or characteristic from the interview, the preschools were divided into two groups, those that had a policy or characteristic that was hypothesized to promote physical activity (PPA) and those did not (NPA) (Table 1). The PPA and NPA groups for physical activity minutes per day were based on recommendations for preschool children.¹ Groupings for other characteristics were based on a previous study.⁶ The categories for PPA group included preschools that reported three or more field trips per month (versus <3), 4 or more community organization visits per month (versus <4), 60 or more minutes of teacher led physical activity per day (versus <60 minutes), 60 minutes of outside minutes per day (versus <60 minutes). They also reported that 50% or more of teachers had college degrees (versus < 50%), that teachers had received physical activity training recently (in the past two years), and there was 120 minutes of physical activity opportunities per day (versus <120 minutes).

Preschool Quality

One of the researchers who had been trained to use the Early Childhood Environment Rating Scale-Revised Edition (ECERS-R)⁸ administered it in one classroom at each preschool. The ECERS-R evaluates levels of quality based on current understanding of recommended practices in early childhood education. The ECERS-R has seven dimensions which evaluate space and furnishings, personal care routines, language-reasoning, activities, interaction, program structure, and provisions for parents and staff. The scale includes 43 items that are rated from 1 to 7 on a Likert-type scale, with a score of 1 for inadequate and 7 for excellent. In this study, scores from each subscale were added and divided by the number of items. The psychometric properties of the ECERS-R have been reported elsewhere.⁸ Higher quality preschools had higher scores, and preschools were divided into two groups using an overall average score of 5, which represents a good score (≤ 5 :NPA, or > 5 : PPA).

Electronic Media

The Observational System for Recording Physical Activity in Children-Preschool Version (OSRAC-P) was used to record indoor activity codes while children were inside the preschools.⁹ Children in the 24 preschools (n=476) were observed for a minimum of 600, 30-second observation intervals (i.e., 5 hours per child). Preschools were divided into high or low electronic media use based on the percent of intervals in which children were observed using electronic media (TV/Movies/Computer) while inside the preschool. Of the intervals that were coded as electronic media, over 40% were from four of the preschools ($> 7\%$ of electronic media codes each); these were classified as high electronic media preschools (NPA) for the current study.

Preschool Sizes and Equipment Inventories

Data collectors measured classrooms and playgrounds used by 3-5-year-olds at each of the preschools, and the sizes were averaged across a preschool. Preschools were divided into those in the upper quartile of size (PPA) versus those in the 3 lower quartiles (NPA). The number of children in each class of 3-, 4- and 5-year-olds also was determined, and preschools with fewer

than 15 children per classroom were hypothesized to be in the physical activity promoting group (PPA). Counts were made of fixed playground equipment for physical activity (e.g., jungle gyms, slides, and swings) and portable equipment (e.g., balls, tricycles) brought to the playground. Preschools were divided into two groups at the median for portable equipment (range 0-8; median=1) and fixed equipment (range 3-14; median=8).

Accelerometry

Children wore ActiGraph accelerometers (Model 7164; Pensacola, FL) over a two-week period. The ActiGraph is a uniaxial accelerometer that measures acceleration in the vertical plane; it is small ($2.0 \times 1.6 \times 0.6$ inches); light (1.5 ounces); and unobtrusive. Its acceleration signal is filtered by an analog bandpass filter (0.1 -3.6 Hz) and digitized by an 8-bit A/D converter rate of 10 samples per second, storing data in user-defined intervals. For the present study, the monitors were initialized to save data in 15-second intervals to detect the short bursts of activity that are characteristic of 3- to 5-year-old children.

Participants wore the accelerometers on an elastic belt on the right hip (anterior to the iliac crest). Parents were instructed to remove the accelerometer only during water activities (bathing, swimming) and when the child went to bed at night. Accelerometers were replaced prior to the weekend and again on the following Monday. Data were later linked by child. Sixty-minutes of consecutive zeros were considered as non-wear time. On weekdays, a child must have attended school for ≥ 5 hours in order for the data for that day to be included in the analyses.

Trained data collectors recorded arrival and departure times from the preschool for each child, using sign in and out sheets that had been completed by the parent or guardian. Days that a child was absent from preschool were not included. Occasional missing entry and exit times were imputed from the child's other data (usual times entered on the consent form, entry and exit times on other days, and school average entry and exit times) using a SAS program that weighted the child-specific data more heavily than the school-level data.

Accelerometer data were reduced using cut-points developed specifically for 3- to 5-year-old children to categorize each interval as sedentary (< 36.5 counts/15-sec), and moderate to vigorous (MVPA; > 420 counts/15-sec).¹⁰ In-school minutes per hour of sedentary and MVPA were then calculated, using each child's time spent in the preschool as the divisor. For the present study, only physical activity that occurred during the preschool day was of interest and analyzed. On average, children wore the accelerometer for 8.1 hours (SD=1.5) for 5.5 days (SD=2.1) while in preschool.

Body Mass Index

Children's height was measured to the nearest 0.1 cm using a portable stadiometer (Shorr Productions; Olney, MD). Weight was measured to the nearest 0.1 kg using an electronic scale (Seca, Model 770; Hamburg, Germany). The average of two measurements was used for both height and weight. Body Mass Index (BMI) was calculated by dividing weight in kilograms by height in meters squared (kg/m^2).

Parent Survey

A parent or guardian completed a survey that included questions about the child's date of birth, gender, race, and the level of education of adults in the household.

Statistical Analyses

Descriptive statistics were calculated for the 299 children. For each policy or characteristic of the preschool, the preschools were divided into two groups based on whether a characteristic

of the preschool was hypothesized to be physical activity promoting (PPA) or not (NPA). Mixed model ANOVAs were used to determine if there were differences in sedentary and MVPA minutes per hour between each of the two groups. Mixed models handle multilevel data where the unit of analysis is not the individual, but a naturally occurring group such as a school. To control for the correlation between children within a preschool (with a common social and physical environment), preschool was entered as random variable. Then a mixed model ANOVA was run for each characteristic, controlling for child-level variables BMI, race, sex, parent education and age of child, all of which have been associated with physical activity,^{3,4} and with preschool as a random variable. A final model was run in which the preschools were categorized into two groups based on whether or not they had all of the characteristics that were significant from the separate ANOVA results.

Results

Of the 299 children, 50% were males, 49 % African American, 42% White, 10% Other race/ethnicity, 38.5% were 3 years, 47.8% were 4 years, and 13.7% were 5 years of age. Average BMI was 16.6 (SD=3.8), and 54% of the children had a parent with greater than a high school education.

Table 2 shows results of separate mixed model ANOVAs for the physical activity promoting characteristics, controlling for BMI, race, sex, parent education, and with preschool as a random variable. Children had fewer sedentary minutes per hour in PPA preschools that had higher quality (ECERS-R >5), lower electronic media usage, one or more pieces of portable equipment on the playground, less fixed playground equipment, and larger playgrounds. Children had higher MVPA in PPA preschools that had higher quality (ECERS-R >5), lower electronic media usage, one or more pieces of portable equipment on the playground, less fixed playground equipment, and larger playgrounds. Also included in Table 2 is the model that compares the preschools that were characterized by having all five characteristics that were significantly associated with physical activity. Higher PPA preschools had higher quality, lower electronic media usage, more pieces of portable equipment on the playground, less fixed equipment on the playground, and larger playgrounds. These five higher PPA preschools had significantly lower sedentary time and higher MVPA than the lower PPA preschools. All five of the higher PPA preschools also had provided recent physical activity training for the teachers.

Discussion

A preliminary step in planning interventions for preschool children is to determine the factors of the preschool environment that influence the physical activity of the children. In this study, accelerometers were used to measure physical activity in children from 20 preschools during the preschool day. Children spent fewer minutes per hour in sedentary activity and more minutes per hour in MVPA in preschools that had higher quality scores, less fixed playground equipment, more portable playground equipment, lower electronic media use, and larger playgrounds. These findings suggest that educators and health professionals can modify the preschool environment in ways that help children spend more time in physical activity and less time in sedentary pursuits.

Children in higher quality preschools participated in less sedentary activity and more MVPA than children in lower quality preschools. In a previous study, the ECERS-R was used to measure quality in nine preschools; children in preschools in the upper quartile of scores (higher quality) were observed to spend less time in sedentary activities compared to children in preschools with lower ECERS-R scores.⁶ Bowers et al. used the Environmental and Policy Assessment and Observation (EPAO) instrument to quantify both the social and physical

environment of 22 preschools.⁷ Children in preschools with higher EPAO scores were observed to spend significantly higher percent of time in MVPA and lower percent of time in sedentary activity. In the present study, all three types of preschools were included in the higher quality preschool group. This suggests that different types of preschools (i.e., Head Start, commercial, faith based), with probably different levels of financial resources, can promote physical activity.

Children in preschools with more fixed playground equipment (e.g., slides, jungle gyms) were less active than children in preschools with less fixed equipment. Also, children in preschools with more portable equipment (e.g., balls, tricycles) were more active than children in preschools with less portable equipment. Other researchers have found similar results.^{7,11,12} One reason for increased sedentary behavior with fixed playground equipment may be that children tend to congregate on and under the equipment. Brown et al., using an observational system (OSRAC-P), reported that when children were observed on fixed playground equipment, only 13% of the intervals were spent in MVPA. Twice as many intervals were spent in MVPA when the children had balls and other portable physical activity equipment.¹³ Preschools can increase children's activity levels by providing balls and equipment for active games, which typically are inexpensive and can be rotated in and out for variety.

Consistent with other studies^{14,11,15} playground size was also an important characteristic of the PPA preschools. Experts recommend that playgrounds should have a minimum of 75 square feet of outdoor play area for each child.¹ Preschools with smaller playgrounds may need to schedule playtime so that fewer children are on the playground at one time.

Children in preschools with lower electronic media use participated in significantly fewer minutes of sedentary activity and more minutes of MVPA per hour. Studies of physical activity and television viewing in preschool age children have produced inconsistent results.¹⁶ Bower et al. reported that when more TV and computers were present in the preschool, children participated in higher levels of physical activity.⁷ However, electronic media was measured differently in the present study, compared to Bower et al. Rather than dividing the preschools into groups based on number of TV and computers that were present, preschools were divided into high and low usage, based on observations of the children actually using electronic media in the preschools. The measure of number of computers and TVs used in the Bower's study may have been a measure of financial resources available to the preschools. The findings in the present study suggest that preschools that limit electronic media use can decrease the time children spend in sedentary activities and increase their physical activity.

Strengths of the present study include the use of accelerometers to measure physical activity and the use of objective measures to classify preschools into PPA and NPA categories. Also, the sample included high percentages of both white and African American children and children of various ages and body sizes. However, the study was cross-sectional and these findings need to be studied longitudinally. Also, all of the preschools were located around one city in South Carolina and this may limit generalizeability.

Conclusions

The highest levels of MVPA (66 minutes in the PPA preschools compared to 53 minutes in the NPA preschools over an 8 hour day) and lowest levels of sedentary minutes per hour were in the five preschools with the physical activity promoting characteristics of higher quality, lower electronic media use, more portable equipment on the playground, less fixed equipment on the playground, and larger playground size. Teachers at these preschools also had recent physical activity training. Of these 5 preschools, one was commercial, two were Head Starts, and two were faith based. Preschool personnel can encourage physical activity by providing

inexpensive portable playground equipment, limiting access to fixed equipment, limiting the number of children on the playground at any one time, and limiting electronic media use. Preschools can provide opportunities for children to accumulate at least 60 minutes of MVPA each day.¹⁷

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Abbreviations

PPA

promoting physical activity

NPA	not promoting physical activity
MVPA	moderate-to-vigorous physical activity
ECERS-R	Environment Rating Scale-Revised Edition
BMI	body mass index

Table 1

Characteristics and policies of 20 preschools

Variable	Source	Hypothesized Non-promoting Physical Activity (NPA)	Hypothesized Promoting Physical Activity (PPA)	PPA	
				Preschools n	Children n / %
Quality	ECERS-R	< 5	> 5	12	197/ 65.8
Field Trips per month	Director Interview	0-2	3 or 4	4	60/ 20.1
Community Organization visits/month	Director Interview	< 4	4	10	170/ 56.9
Teacher led physical activity (Minutes per day)	Director Interview	< 60 minutes	> 60 minutes	8	103/ 34.5
Minutes outside per day	Director Interview	< 60 minutes	> 60 minutes	13	173/ 57.9
Teachers education (% with college degrees)	Director Interview	< 50%	> 50%	6	114/ 38.1
Physical activity opportunities per day	Director Interview	< 120 minutes	> 120 minutes	7	100/ 33.4
Teachers had recent physical activity training	Director Interview	No	Yes	16	260/ 87.0
Electronic Media	OSRAC-P	> 7% of observations	< 7% of observations	16	240/ 80.3
Portable playground equipment	Observation	0	> 1	14	185/ 61.9
Fixed playground equipment	Observation	> 8	< 8	9	155/ 51.8
Children per class room	Numbers From Director	> 15	< 15	5	74/ 24.7
Playground size	Measure and averaged over all playgrounds	< 4157 sq ft	≥ 4157 sq ft	17	248/ 82.5
Classroom size	Measured and averaged over all classrooms	< 347 sq ft	≥ 347 sq ft	15	225/ 75.3

* Total number of children= 299

Table 2
Results of Mixed model ANOVAs for minutes per hour of MVPA and Sedentary Activity

PA Characteristic	Sedentary			MVPA		
	PPA N Mean (SE)	NPA promoting N Mean (SE)	p-value	PPA N Mean (SE)	NPA promoting N Mean (SE)	p-value
Quality	32.8 (0.8)	36.1 (1.1)	.01	7.5 (0.3)	6.2 (0.4)	.01
Field trips per month	34.9 (1.7)	33.8 (0.8)	.58	7.2 (0.6)	7.0 (0.3)	.81
Community Organizations visits/month	34.0 (1.1)	34.1 (1.1)	.98	6.9 (0.4)	7.2 (0.4)	.60
Teacher led physical activity	33.6 (1.2)	34.3 (1.0)	.64	7.0 (0.5)	7.0 (0.4)	.95
Minutes outside per day	34.4 (0.9)	33.4 (1.3)	.55	7.2 (0.4)	6.8 (0.5)	.50
Teacher education	33.8 (1.3)	34.1 (0.9)	.85	6.8 (0.5)	7.1 (0.3)	.57
Physical activity opportunity per day	33.9 (1.3)	34.0 (1.0)	.92	7.3 (0.5)	6.9 (0.4)	.52
Teacher had recent physical activity training	33.6 (0.8)	36.3 (1.8)	.17	7.2 (0.3)	6.2 (0.7)	.18
Electronic media	33.4 (0.8)	36.7 (1.5)	.05	7.3 (0.3)	5.9 (0.6)	.03
Portable playground equipment	33.4 (0.8)	36.7 (1.5)	.05	7.4 (0.3)	6.2 (0.4)	.03
Fixed playground equipment	32.3 (0.8)	35.8 (0.9)	<.01	7.6 (0.3)	6.4 (0.4)	.02
Children per class room	33.0 (1.5)	34.4 (0.9)	.39	7.5 (0.5)	6.8 (0.3)	.26
Room size	33.6 (0.8)	36.5 (1.8)	.13	7.1 (0.3)	6.7 (0.7)	.58
Playground size	33.1 (0.8)	36.7 (1.3)	.02	7.3 (0.3)	6.0 (0.5)	.02
PPA characteristics:	29.9 (1.0)	35.2 (0.6)	<.001	8.3 (0.5)	6.6 (0.3)	.001
Quality,						
Electronic media usage						
Portable playground equipment						
Fixed playground equipment						
Playground size						
(5 preschools, 64 children)						

Controlling for BMI, race, sex, parent education and age of child and preschool as a random variable.

PPA, Promoting physical activity characteristic

NPA, Non-promoting physical activity characteristic

MVPA, moderate-to-vigorous physical activity