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ORIGINAL RESEARCH

Physical Activity in Preschool Children With the Transition to Outdoors

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Background: It is known that children are more physically active outdoors than indoors. However, few previous studies have observed the time course for physical activity as young children transition from indoor to outdoor activities. ***Methods:*** Participants were 3- to 5-year-old children enrolled in the Children's Activity and Movement in Preschool Study (CHAMPS). Trained observers used the Observational System for Recording Physical Activity in Children-Preschool Version (OSRAC-P) to record children's physical activity levels over 20 minutes in outdoor settings. The 20-minute outdoor observational period began immediately following the transition from indoors to outdoors. ***Results:*** Children's activity levels were moderately high at the time of transition and declined over the 20-minute observation period. Different patterns, however, were observed for boys and girls. Overall, boys were more active than girls. Boys' activity levels declined in a linear fashion over the 20-minute period, while girls' activity levels increased slightly, decreased, and then increased slightly again. ***Conclusions:*** These data indicate that physical activity levels decline with increased duration of outdoor play. The frequency and duration of outdoor play should be investigated for the purpose of optimizing physical activity levels.

Keywords: early childhood, child care, young children

A large proportion of American children fail to meet current physical activity guidelines.[1–4] Public health initiatives to promote and facilitate physical activity are needed, and such initiatives in child care and preschool settings may be important, given the large percentage of young children who attend child care and preschool programs.[5] Many of these programs focus on enhancing children's preacademic and school readiness skills,[6–8] which may limit the amount of time they allocate to promoting and supporting children's physical activity.

Historically, outdoor play has been a common component of early childhood programs,[9] and previous research has shown that children generally are more physically active outdoors than indoors.[10,11] This finding suggests that increasing the time preschoolers spend in outdoor recess periods might be an effective strategy for increasing their physical activity during the preschool day.

However, 2 factors, length and frequency of outdoor recess periods, may influence the effects of outdoor time on physical activity levels. For example, McKenzie et al showed that physical activity levels were highest during the first few minutes of recess.[12] In addition, Pellegrini and Davis reported a decrease in physical activity across recess periods.[9] The primary purpose of our preliminary study was to determine, using direct observation, physical activity levels of preschool children following the transition from indoor to outdoor settings and activities.

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Methods

Participants

Participants were 3- to 5-year-old children attending preschools enrolled in the Children's Activity and Movement in Preschool Study (CHAMPS). The study was approved by the University of South Carolina Institutional Review Board (IRB). We invited parents of children who attended 24 preschools in metropolitan Columbia, South Carolina to enroll their preschoolers in the study. A total of 539 children (51% male, 55% African-American) enrolled, and we observed 91% of them (n = 493). Each participating child's parent or guardian provided written informed consent. After deletions for race other than African-American or European-American (n = 38), race unknown (n = 9), insufficient data (n = 3), or missing age (n = 5), data from 438 children were available for analyses.[13] Within this sample we observed 315 children (50.5% male, 56.5% African-American) while they were in outdoor activity settings. However, not all of these children had extensive outdoor data, and we selected 20 minutes spent

outdoors as an appropriate interval for detecting changes over time. Therefore, for the current study, we analyzed information for the 102 children who had transitioned to an outdoor setting and then were observed for at least 20 minutes. The descriptive statistics for these 102 children are presented in Table 1.

Assessment of Physical Activity

We used the Observational System for Recording Physical Activity in Children-Preschool Version (OSRAC-P)[14] to measure children's physical activity in preschools. OSRAC-P is a focal child, momentary time sampling observation system with a 5-second observe interval followed by a 25-second record interval (30-second observation intervals). With the observational system, observers assessed physical activity levels (eg, sedentary, light, moderate-to-vigorous physical activity), activity types (eg, running, sitting, walking, riding), social circumstances (eg, initiator of activity, group composition), and nonsocial conditions (ie, child location, activity contexts). Each observer had extensive training using the OSRAC-P before data collection, and interobserver reliability was high for all 5 physical activity intensity categories (κ = 0.82, 0.80–0.95). Data were collected using INTMAN software[15] with hand-held Dell Axim ×5 computers (Dell World Trade LP, Round Rock, TX).

Physical activity level codes used in the OSRAC-P were modified from the Children's Activity Rating Scale (CARS).[16] Activity intensities were rated on a 1 to 5 scale, with 1 indicating stationary or motionless and 5 indicating fast or vigorous movement. Intervals coded as Level 1 or 2 were considered Sedentary Activity. Intervals coded as Level 3 were viewed as Light Activity, and intervals coded as Levels 4 or 5 were considered Moderate and Vigorous Activity, respectively.

Data for the CHAMPS study were collected in 30-minute sessions, and each child was observed for 10–12 sessions. Two observation intervals were coded each minute, for a total of 600–720 observation intervals per child. The observation sessions were randomly chosen from the hours that each child attended the preschool, and were spread across 10 days. Only children who transitioned from an indoor to an outdoor setting during an observation period and then were observed for at least 20 minutes in the outdoor setting (n = 102) were included in the analyses. If a child had more than 1 outdoor session that met the inclusion criteria, the session with the longest outside observation period was used in the analyses.

Other Measurements

Parents completed a survey that included the child's age, gender, and race/ethnicity, and the parents' level of education. We measured each child's height to the nearest 0.1 cm using a portable stadiometer (Shorr Productions; Olney, MD) and weight to the nearest 0.1 kg using an electronic scale (Seca, Model 770; Hamburg, Germany). The average of 2 measurements was used for both height and weight. We calculated Body Mass Index (BMI) and expressed it as kg/m^2.

Statistical Analyses

We employed growth curve analyses to assess changes in physical activity over the first 20 minutes of outdoor time for 102 children. We used hierarchical linear models (HLM) to show change over time by fitting the slope at the individual level. Our second level of analyses related predictors to interindividual differences in change. Specifically, we used Proc Mixed in SAS (version 9.2) to perform an unconditional growth model, without predictors, to provide the population initial status (intercept), the rate-of-change parameter, and a residual term that represents the between-person variance. We also calculated 2 additional models with gender and weight group (< 85th and ≥ 85th percentile) as predictors. For each of these models, we tested quadratic and cubic terms for time and their interaction with the predictors, and terms that were not significant were dropped from subsequent analyses. For all models, participants were nested within preschools.

Table 1 Characteristics of the Sample of Children Observed During 20 Minutes of Outdoor Play

	Total (n = 102)	Male (n = 48)	Females (n = 54)	*P*
Age	4.2 (0.7)	4.2 (0.6)	4.2 (0.7)	0.86
BMI	17.5 (4.4)	17.3 (4.3)	17.6 (4.6)	0.72
Race				
African American	58.8%	54.2%	63.0%	
European American	37.3%	45.8%	29.6%	0.06
Other	3.9%	0%	7.4%	
Weight status				
< 85th BMI percentile	63.4%	68.8%	58.5%	0.29
≥ 85th BMI percentile	36.6%	31.2%	41.5%	

Results

The mean activity level over the 20 minutes of outdoor time was 2.5 (0.5) for girls, 2.7 (0.5) for boys ($P = .05$), 2.7 (0.5) for children who were normal weight, and 2.5 (0.6) for those with a BMI ≥ 85th percentile ($P = .24$). The unconditional growth model for the total group is presented in Table 2. This model showed that the average initial activity intensity was 2.8, and that activity intensity decreased an average of 0.007 for each subsequent 30-second interval. The variance components of this model indicated significant within-person variability ($\sigma^2 = 1.2$) and between-person variability ($\sigma^2 = 0.44$), showing that some of the variance might be explained by individual characteristics of the children or other unknown variables. The correlation between true initial status and true change was 0.69. This finding indicated that most children with higher physical activity intensities had greater rates of decline in their activity levels over the 20 minutes of time spent outdoors, although some preschoolers increased their activity intensities across time and some maintained a relatively constant activity level. Figure 1 shows the individual linear activity trajectories for each child and an average change trajectory for the 102 children.

We found a gender x time interaction, so we performed models separately by gender. Models were performed for the total group and by gender and weight status categories (Table 2). For boys, the quadratic and cubic terms were nonsignificant, whereas for girls both the quadratic and cubic terms were significant. The models for boys and girls were

a) Boys, Intensity = $2.98 - (.014 \times \text{Time})$

b) Girls, Intensity = $2.35 + (.056 \times \text{Time}) -$
$2.35 + (.056 \times \text{Time}) - (.003 \times \text{Time}^2) + (.0001 \times \text{Time}^3)$.

Figure 2 presents the means by time for boys and girls with a trend line plotted using Excel. The physical activity intensities for boys decreased linearly over the 20 minutes of outdoor play, whereas the physical activity levels for girls increased slightly, decreased somewhat, and then increased slightly again. Table 2 also shows the model for weight status as a predictor. The quadratic and cubic terms were dropped and weight status by time was not significant. In addition, weight status models were run separately by gender, and there was no difference in weight status over time.

Table 2 Growth Curve Models for Intensity of Physical Activity in Preschool Children Over a 20-Minute Outdoor Period

	Total	Males	Females	Weight status
Intercept	2.76 (0.07)[a]	2.98 (0.10)[a]	2.35 (0.12)[a]	2.58 (0.12)[a]
Time	–0.007 (0.002)[c]	–0.014 (0.004)[b]	0.056 (0.019)[c]	–0.002 (0.004)
Time^2			–0.003 (0.001)[b]	
Time^3			0.0001 (0.00002)[c]	
< 85th BMI percentile				0.28 (0.15)[d]
≥ 85th BMI percentile				Referent
Time × < 85th BMI percentile				–0.008 (0.005)
Time × ≥ 85th BMI percentile				Referent
Variance components				
Within person	1.218 (0.03)[a]	1.234 (0.041)[a]	1.199 (0.037)[a]	1.22 (0.03)[a]
In initial status	0.435 (0.08)[a]	0.407 (0.11)[a]	0.375 (0.095)[a]	0.423 (0.08)[a]
In rate of change	0.0004 (0.0001)[a]	0.0005 (0.0001)[a]	0.0003 (0.0001)[a]	0.0004 (0.0001)[a]
Covariance	–0.009 (0.002)[a]	–0.010 (0.004)[b]	–0.006 (0.003)[c]	–0.009 (0.002)[a]
Deviance	12701.7	6002.8	6678.3	12569.9
Akaike Information Criterion	12713.7	6014.8	6694.3	12585.9
Bayesian Information Criterion	12729.4	6026.0	6710.1	12606.7

[a] $P < .001$; [b] $P < .01$; [c] $P < .05$; [d] $P < .10$.

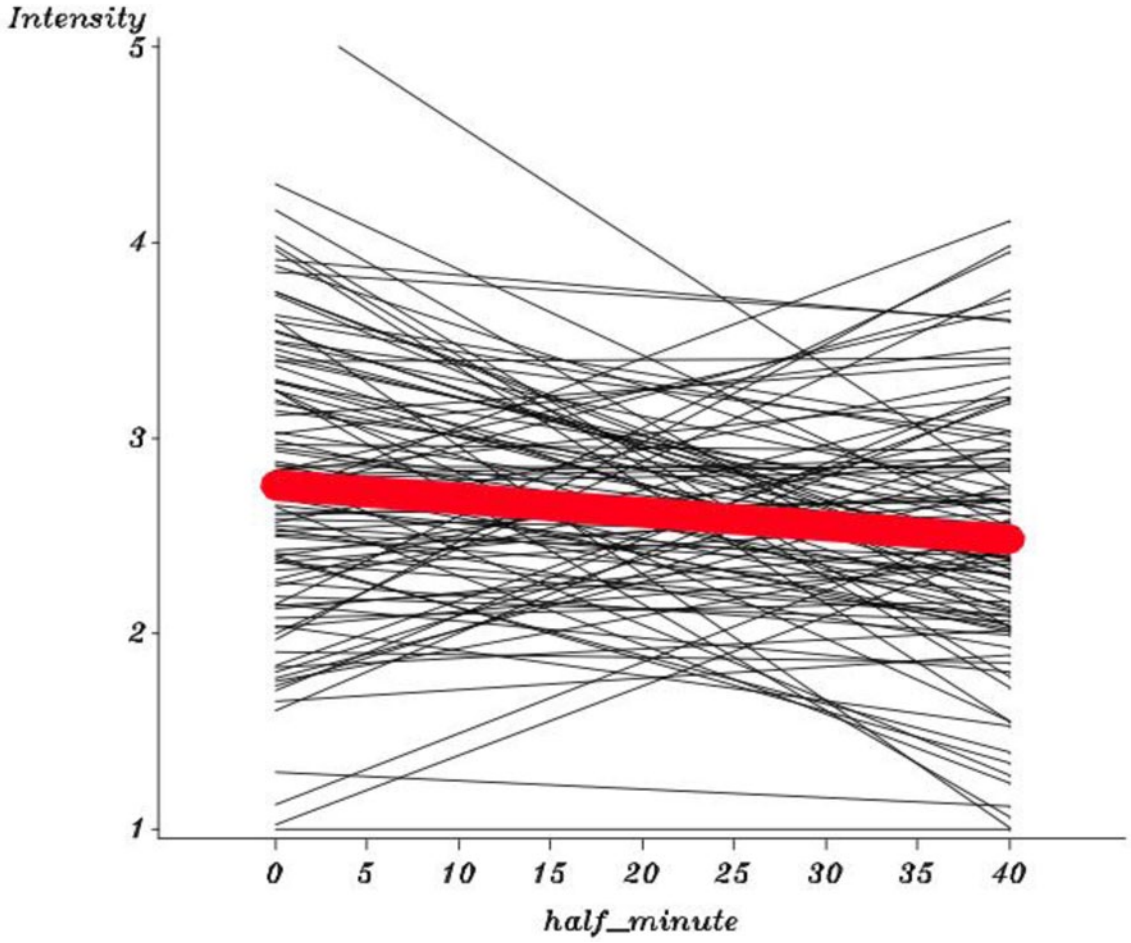

Figure 1 — Ordinary least squares individual growth trajectories for intensity over 20 minutes (40 half-minute intervals) of observation for 102 preschool children and their mean trajectory.

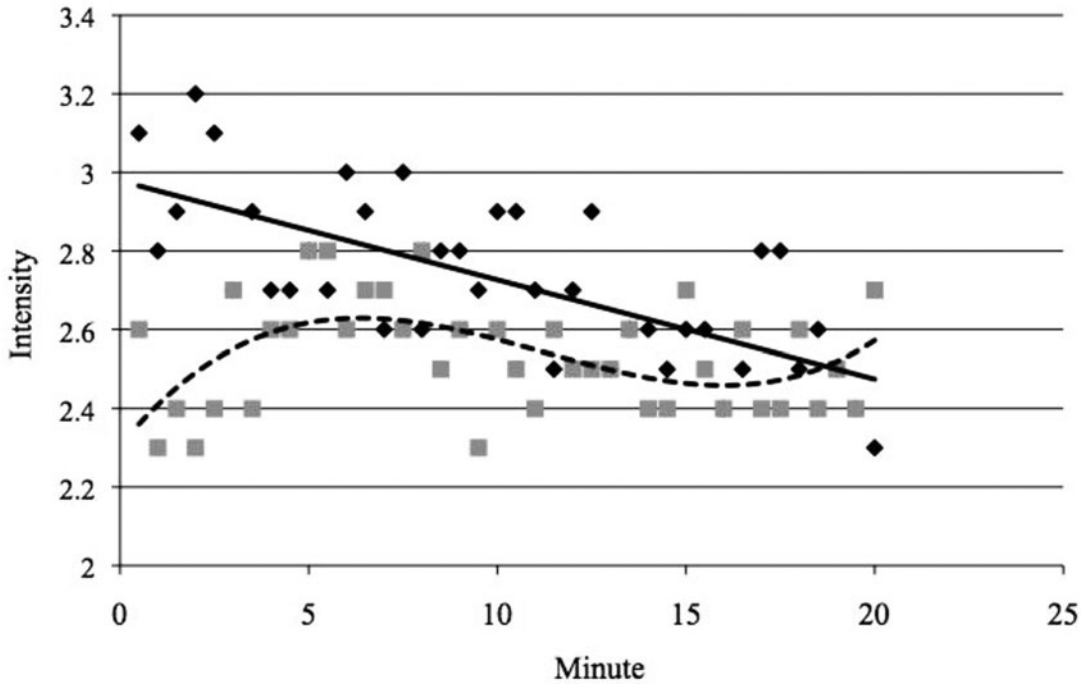

Figure 2 — Average intensity per minute for males (♦) and females (■), with linear plot (—) for males and polynomial plot (– –) for females.

Discussion

The preliminary data presented provide evidence that preschoolers' physical activity levels declined during 20 minutes of outdoor time, after transitioning from an indoor setting. Specifically, we observed that physical activity levels in boys declined linearly over time, whereas physical activity levels in girls decreased in a curvilinear pattern. These data suggest that the frequency and duration of outdoor play during the preschool day may influence children's physical activity levels, and that simply increasing the amount of time spent outdoors may not be the best approach to promoting physical activity. Additional research is needed to identify the timing and frequency of outdoor play time that maximizes physical activity levels.

Similar to our findings, McKenzie et al studied U.S. children (preschool and elementary) and found that the percent of time spent in moderate-to-vigorous physical activity declined during the first 10-minutes of recess, with the steepest decline occurring within the first 3 minutes.[12] Similarly, Cardon et al found that shorter periods of outdoor time were a predictor of higher levels of physical activity.[17] Allowing for brief and more frequent periods of outdoor time could lead to higher levels of physical activity, through the accumulation of the initial physical activity "peaks." Further, an experimental study of U.K. preschool children found that higher levels of physical activity occurred after the children were confined indoors for longer (1.5 hours) versus shorter (0.5 hours) periods.[18] It may, therefore, be important to consider the prior time spent indoors when determining the frequency of outdoor periods in relation to optimizing outdoor physical activity.

Future research is needed to build upon our findings in several areas. First, we interpreted the mean change in physical activity over time and, due to the interindividual variability of physical activity in our sample, larger studies using latent class modeling could advance this area of research. Second, there is evidence that larger playground size and the presence of playground equipment are associated with increased levels of physical activity in preschool children.[17,19,20] Additional research into outdoor physical activity levels in more diverse playground settings is needed to address this issue. Finally, additional research is needed to determine if social factors influence physical activity levels during outdoor play in preschool children.[21]

In conclusion, outdoor physical activity levels declined over a 20-minute outdoor period, after transitioning from an indoor setting, in a sample of preschool children. Future studies are needed to determine if physical activity levels in preschool children could be increased by adopting shorter and more frequent outdoor time periods throughout the day.

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