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Social and Environmental Factors Associated With Preschoolers' Nonsedentary Physical Activity

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The twofold purposes of the investigation were (a) to describe with direct observation data the physical activity behaviors and the accompanying social and environmental events of those behaviors for children in preschools and (b) to determine which contextual conditions were predictors of moderate to vigorous physical activity (MVPA) and nonsedentary physical activity (i.e., light activity + MVPA) for 3-, 4-, and 5-year-old children during their outdoor play. The results indicate that preschoolers' physical activity is characterized as sedentary in nature throughout their preschool day (i.e., 89% sedentary, 8% light activity, and 3% MVPA). During outdoor play periods, when children are most likely to be physically active, some contextual and social circumstances better predict their physical activity. Implications for policy makers, practitioners, and researchers are discussed.

Recently, the childhood obesity rate has increased considerably in the United States, and many children are becoming overweight at younger ages. Ogden et al. (2006) reported that the prevalence rate of at risk for overweight (i.e., $\geq$ 85th percentile) among 2- to 5-year-old children in the United States was 26.2%, and during the past 5 years, the rate increased by 4.2%. Within the United States, some populations, such as African American, Hispanic, and low-income children, have had even higher prevalence rates for childhood weight difficulties (e.g., Haas et al., 2003; Sherry, Mei, Scanlon, Mokdad, & Grummer-Strawn, 2004). Moreover, Trost, Sirard, Dowda, Pfeiffer, and Pate (2003) noted that early incidence of being overweight might inhibit young children's physical activity, negatively affecting their future weight status. Finally, Guo, Wu, Chumlea, and Roche (2002) and Baker, Olsen, and Sorensen (2007) reported that children's early overweight problems predict adult obesity and significant health problems.

The causal nexus between obesity and severe health problems is multifaceted and any connection may be confounded by the fact that both health problems and obesity have been associated with poor diet and lack of exercise. Nevertheless, obesity has been clearly associated with multiple health difficulties, most notably, coronary heart disease, hypertension, Type II diabetes, osteoporosis, and some types of cancer (e.g., Blair & Brodney, 1999; Must et al., 1999). Many public health researchers have hypothesized that obesity is related to contemporary diets and physical inactivity (e.g., Biglan, 2004; Troiano & Flegal, 1998). Specifically, modern diets have increased caloric intake, particularly calories with saturated and trans fats and sugars, and the physical activity levels of many adults and children have become predominantly sedentary in nature (Nestle, 2002; Popkin, 2007).

Given these troubling overweight trends, the U.S. Department of Health and Human Services (2000), the Centers for Disease Control and Prevention (2004), and the Council on Sports Medicine and Fitness and Council on School Health (2006) have declared that prevention of childhood obesity is an urgent national health priority. Indeed, public health researchers have noted that poor diet and sedentary activity are approaching cigarette smoking as one of the leading factors in preventable deaths (e.g., U.S. Department of Health and Human Services, 2001).

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With respect to early childhood policy, recent statements by Story, Kaphingst, and French (2006) and Krishnamoorthy, Hart, and Jelalian (2006) recommended policy and practice research to address issues related to the children's overweight problems.

Concurrent with the recent overweight trend, the number of preschoolers served in center-based programs (e.g., child-care centers, Head Start programs, publicly funded prekindergartens, and private preschools) has increased dramatically (Fuligni, Brooks-Gunn, & Berlin, 2003; Kagan & Newman, 2000). According to recent estimates, over 60% or more than 4.2 million 3-, 4-, and 5-year-old children who are not in kindergarten were served in center-based preschools in the United States (Federal Interagency Forum on Child and Family Statistics, 2008). The significant numbers of preschool children enrolled in center-based programs and young children's emerging overweight trends indicate that those community settings may be important contexts for preventive health efforts related to enhancing their well-being in general and physical activity in particular (cf. Pate, 2001). Indeed, Barnett, O'Loughlin, Gauvin, Paradis, and Hanley (2006) asserted that schools might be productive locations for improving children's physical activity; they also speculated that children's school activity experiences might promote future favorable health behaviors and attitudes about physical fitness (cf. Bandura, 2004).

Currently, we have limited information about preschool children's physical activity in community-based settings (cf. Fulton et al., 2001; Pate, 2001), particularly direct observation data of proximal contextual conditions associated with their activity (Sirard & Pate, 2001). The existing data have been based on relatively modest samples of preschoolers (e.g., Noland, Danner, DeWalt, McFadden, & Kotchen, 1990) and have provided only global information about the social (e.g., adult prompts) and environmental circumstances (e.g., inside vs. outside) associated with children's physical activity (e.g., Baranowski, Thompson, DuRant, Baranowski, & Puhl, 1992; McKenzie et al., 1997). In studies performed with young children, investigators have shown that physical activity levels are lower than expected (see Oliver, Schofield, & Kolt, 2007, for review). For example, Salbe, Fontvieille, Harper, and Ravussin (1997) reported low levels of physical activity in 5-year-old children using doubly labeled water energy expenditure measures. With direct observation measures, Sallis, Patterson, McKenzie, and Nader (1988) determined that 3-, 4-, and 5-year-old children in preschools spent 60% of their outdoor playtime in sedentary activities and only 11% in moderate to vigorous physical activity (MVPA). Similarly, Pate, Pfeiffer, Trost, Ziegler, and Dowda (2004) with accelerometry (i.e., activity measurement using mechanical devices) and Pate, McIver, Dowda, Brown, and Addy (2008) with direct observation found that young children participated in less than the recommended levels of MVPA during their preschool day.

Although accelerometry has been the objective measure of choice for young children's physical activity (e.g., Reilly et al., 2003; Sirard & Pate, 2001), accelerometry alone has been insufficient for determining the proximal contextual circumstances of children's physical activity (cf. Oliver et al., 2007; Pate, 2001). Given the current dearth of direct observation information concerning preschool children's physical activity, the purposes of our study were twofold: (a) to describe with direct observation data the physical activity behaviors and the accompanying social and environmental events of those behaviors for a sample of young children in community-based preschools and (b) to determine which contextual conditions were predictors of MVPA and nonsedentary physical activity (i.e., light activity + MVPA) for children during their outdoor play periods in preschools.

Method

Participants and Settings

Participants were preschool children enrolled in 24 preschools in a metropolitan area of South Carolina. Our overall goal for the Children's Activity and Movement in Preschools Study (CHAMPS) was to provide multimeasure and multisource information to inform the development of practices and policies related to children's physical activity within preschools. One of our three specific aims was to identify the immediate social and nonsocial contextual conditions that are associated with physical activity of children in preschools. The sampling frame for CHAMPS was community-based programs with an enrollment of at least 45 children who were 3, 4, and 5 years old not yet in kindergarten. We solicited directors of preschools for enrollment using a stratified random process with participating programs selected from one of the three types: (a) commercial child-care centers, (b) church-affiliated preschools, and (c) Head Start programs. We categorized eligible preschools into program types and then randomly selected them for participation based on a representative number of preschools from each of the three program types. If a preschool director declined to participate, the administrator from the next randomly selected program was solicited. We solicited 32 preschools, and 24

administrators agreed to participate (i.e., 12 child-care centers, 8 church-affiliated preschools, and 4 Head Start programs). Following preschool selection, we solicited all parents of 3-, 4-, and 5-year-old children enrolled in the program to participate in CHAMPS. In each preschool, we collected cross-sectional study information across 2.5 years with two separate waves of data collection separated by 13–19 months (i.e., 2005–2007). The number of participants per preschool ranged from 14 to 33 children for 539 children. From the larger pool of 539 study participants, we directly observed 476 children, who were 51% males and 55% African Americans, for 5–6 hr in their preschools (Pate et al., 2008). The participation rate for preschoolers and their families was 32.9% of the eligible children in the 24 centers. With respect to children who were observed for the present analyses, 50% inside, and 51% outside, were males. Their self-identified ethnicities along with additional demographic information are also delineated in Table 1.

Study Procedures

Direct observational procedures for children's physical activity. We developed a direct observation protocol entitled the Observational System for Recording Physical Activity in Children–Preschool Version (OSRAC–P; see Brown et al., 2006, for details). The OSRAC–P includes eight observational categories with accompanying codes for recording children's physical activity behaviors and contextual circumstances related to those behaviors. The OSRAC–P affords observers the opportunity to record five levels of children's physical activity (i.e., stationary/motionless, stationary with limb or trunk movement, slow easy activity, moderate activity, and vigorous activity) and the primary topographies (e.g., running, sitting, and standing) associated with those levels of physical activity. In addition, the OSRAC–P documents the immediate social (i.e., initiator of activities, group compositions, and prompts for physical activity) and nonsocial environmental circumstances (i.e., primary locations, indoor activity contexts, and outdoor activity contexts) related to children's physical activity. The system was a focal child, momentary time sampling, with all coding decisions made in reference to a preselected child during each 30-min observation (i.e., 5-s observe and 25-s record with 2 observations/min for 60 intervals per session). Observers recorded information on handheld Dell Axim computers with an accompanying observational software (*INTMAN*; Tapp & Wehby, 2000). Following development of the OSRAC–P, observers were trained in situ for several weeks in a variety of circumstances in two preschools not used for the subsequent study. We employed a training method recommended by Hartmann and Wood (1990) that ranged from informal preschool observations and initial memorization of observational codes to extensive in situ practice of the observational protocol to a criterion of 80% interobserver agreement (IOA) across three consecutive training days.

Table 1
Participant Characteristics of 476 Preschool Children Observed Inside and 372 Observed Outside

Characteristic	476 children observed inside, % or *M* (*SD*)	372 children observed outside, % or *M* (*SD*)
Gender		
Males	50	51
Females	50	49
Ethnicity		
African American	54	52
European American	38	40
Latino/Hispanic	1	2
Asian	1	2
Other	6	5[a]
Parent education		
High school or less	16	17
Technical school/some college	30	30
≥ College graduate	54	53
Age	4.2 (0.7)	4.2 (0.6)
BMI (kg/m^2)	16.5 (2.6)	16.6 (2.8)
Preschool type		
Commercial child-care centers	48	49
Church-affiliated preschools	32	24
Head Start programs	20	27

Note. BMI = body mass index.
[a]With rounding, percentages slightly exceed 100%.

During data collection, observers distributed observations across children, days, and the daily preschool schedule, and their observations were performed across consecutive activities (e.g., large group to transition to outdoor play, center time to transition to group, and lunch to transition to nap time). We observed indoor activities of 476 children for a mean of 655 intervals or mean of 327.5 min per child observed inside with an standard deviation of 59 intervals or standard deviation of 29.5 min. We observed outdoor activities of 372 children on playgrounds with a mean of 68 intervals or a mean of 34 min per child observed outside with an standard deviation of 49 intervals or standard deviation of 24.5 min.

IOA measures. During data collection, we collected IOA measures with two observers simultaneously but

independently recording observational data across children, days, times of day, and settings and circumstances within preschools. We performed six hundred and eighty-one 30-min IOA sessions for a sample of 11.6% of the total observations. Table 2 shows the kappa coefficients and interval-by-interval IOA score means, standard deviations, and ranges for the eight OSRAC – P categories. In all categories, we achieved substantive IOA on an interval-by-interval agreement basis. Although the interval-by-interval agreements for prompts for physical activity were high, a low kappa coefficient resulted because teacher and peer prompts were extremely rare behavioral events (i.e., occurred on only 78 of 305,484 observed intervals with kappa coefficient = .27).

Descriptive and statistical analyses. We calculated the number of intervals observed and the percentage of the recorded intervals in sedentary (Activity Levels 1 and 2), light (Activity Level 3), and moderate to vigorous (Activity Levels 4 and 5) physical activity levels by (a) primary locations, (b) physical activity types, (c) indoor activity contexts, (d) outdoor activity contexts, (e) activity initiators, (f) group compositions, and (g) adult and peer prompts for physical activity. Our rationale for aggregating physical activity Levels 1 and 2 as sedentary and Levels 4 and 5 as MVPA was that those composites represent the two ends of children's physical activity continuum and those combinations have been a common method for representing children's physical activity (e.g., Finn, Johannsen, & Specker, 2002; Pate et al., 2004).

Basic descriptive analysis used all the observed intervals for children within an observational category. The total observed intervals varied across the OSRAC – P observational categories and were (a) primary locations (305,560 intervals), (b) physical activity types (305,493 intervals), (c) indoor activity contexts (264,854 intervals), (d) outdoor activity contexts (29,685 intervals), (e) activity initiators (305,492 intervals), (f) group compositions (305,460 intervals), and (g) adult and peer prompts for physical activity (305,484 intervals). Several procedural reasons exist for the differences in the frequency of observed intervals for the eight OSRAC – P categories. First, whenever the primary location of transition was recorded as children were moving between the indoor and the outdoor locations, indoor and outdoor activity contexts were not coded. Second, when the primary location was indoor, only the indoor activity contexts were recorded, and similarly, when the location was outside, only the outdoor activity contexts were coded. Third, whenever children entered the bathroom, although we recorded the indoor primary location and self-care activity context, we did not intrude by attempting to observe their physical activity levels or types or other codes.

Following the basic descriptive analysis, given that most of the children's observed light physical activity (i.e., 27% outdoors vs. 5% indoors) and MVPA (i.e., 17% outdoors vs. 1% indoors) occurred during their outdoor play periods, we performed a series of logistic regression analyses for three outside

Table 2
Kappa Coefficient and Interval-by-Interval Interobserver Agreement Score Means, Standard Deviations, and Ranges for the Eight OSRAC – P Categories

Observed category		*M*	*SD*	Range
Physical activity levels	Kappa coefficient	.82	.06	.00 – 1.00
	Interval-by-interval agreement	.91	.02	.47 – 1.00
Physical activity types	Kappa coefficient	.94	.05	.00 – 1.00
	Interval-by-interval agreement	.97	.03	.08 – 1.00
Primary locations	Kappa coefficient	.93	.13	.00 – 1.00
	Interval-by-interval agreement	.99	.06	.00 – 1.00
Indoor activities	Kappa coefficient	.95	.08	.00 – 1.00
	Interval-by-interval agreement	.91	.08	.00 – 1.00
Outdoor activities	Kappa coefficient	.92	.16	.00 – 1.00
	Interval-by-interval agreement	.99	.02	.43 – 1.00
Initiator of activities	Kappa coefficient	.91	.18	.00 – 1.00
	Interval-by-interval agreement	.99	.04	.22 – 1.00
Group compositions	Kappa coefficient	.85	.05	.00 – 1.00
	Interval-by-interval agreement	.94	.03	.13 – 1.00
Adult and peer prompts	Kappa coefficient	.27	.27	.00 – 1.00
	Interval-by-interval agreement	.99	.04	.73 – 1.00

Note. OSRAC – P = Observational System for Recording Physical Activity in Children – Preschool Version.

contextual conditions: (a) outside activity contexts, (b) initiator of activities, and (c) group compositions. The regression analyses were conducted for two aggregations of activity levels: (a) MVPA (Levels 4 and 5) and (b) nonsedentary physical activity (Levels 3, 4, and 5). Given that Level 3 light activity was exhibited much more often outside, we also decided to perform regression analyses on that combination of activity to characterize children's outside nonsedentary activity. For all regression models, we adjusted statistically for gender, age, body mass index, and ethnicity with individual observations, nested within child and center as random effects (i.e., interval as unit of analysis).

All statistical analyses were performed using SAS 9.1 software (SAS Institute, Cary, NC). Three models were developed with independent categorical variables of (a) the five most common outside activity contexts (i.e., open space, fixed equipment, balls and objects, sociodramatic props, and wheel toys), which constituted 88% of the outdoor observations; (b) initiator of activities; and (c) group compositions (i.e., solitary, one-to-one with peer, group without adults, or adults present) for the two activity outcome variables: (a) MVPA versus sedentary behavior and (b) light physical activity + MVPA versus sedentary behavior.

Results

For the 476 children in the present study, we collected multiple observation intervals with the OSRAC–P system across the preschool day. Table 3 delineates the number of observed codes followed by the proportion of intervals recorded as (a) sedentary physical activity (Activity Levels 1 and 2 combined), (b) light physical activity (Activity Level 3), and (c) MVPA (Activity Levels 4 and 5 combined).

Primary Locations Observed Within Preschools

With respect to general location of observations, 264,809 intervals, which constituted about 87% of the observations, were recorded as inside preschool buildings and not in transition. During these inside observations, children's physical activity levels were overwhelmingly sedentary in nature, with 94% of total intervals recorded as sedentary and only 1% of them coded as MVPA. Outside location was recorded for 29,694 intervals, which consisted of slightly less than 10% of the observations. Transitions between inside and outside locations were recorded on 10,993 intervals, which constituted about 3.5% of the total observations. Although observed in transition, MVPA was recorded on 4% of the intervals, whereas when outdoors, children exhibited higher activity levels with 17% of the intervals observed in MVPA.

Topography of Physical Activity Behaviors Within Preschools

With respect to the 17 behavioral types of children's physical activity, 89% of the intervals were three sedentary behaviors: (a) sit/squat, (b) lie down, and (c) stand, and active types of physical activity were observed much less often. Specifically, the five most commonly observed active behavioral topographies were (a) walking (7% MVPA), (b) running (100% MVPA), (c) crawling (4% MVPA), (d) jumping or skipping (56% MVPA), and (e) climbing (29% MVPA) and those five behaviors constituted slightly more than 10% of observations.

Indoor Activity Contexts

With respect to indoor activity contexts, children were observed in a range of activities. The five most common activity contexts were primarily inactive in nature: (a) nap time (99% sedentary), (b) large group (96% sedentary), (c) indoor transition (81% sedentary), (d) snack (97% sedentary), and (e) manipulative (91% sedentary). These circumstances constituted 84% of all observed intervals during indoor activities. Teacher-arranged physical activity and music were infrequent indoor activities (i.e., $< 1\%$ of intervals), but when they were implemented, they were related to relatively high levels of physical activity (i.e., 8% and 4% of intervals coded as MVPA, respectively).

Outdoor Activity Contexts

With respect to outdoor activity contexts, children were observed in a range of playground circumstances with many more intervals of nonsedentary physical activity than inside contexts. The five most common outdoor activity contexts were (a) open space (23% MVPA), (b) fixed equipment (13% MVPA), (c) ball and object use (26% MVPA), (d) sociodramatic props (10% MVPA), and (e) wheel toys (14% MVPA and those five contexts constituted 88% of the observations). Nevertheless, when three low-frequency outdoor activity contexts occurred, they were related to relatively high proportions of MVPA. Specifically, although teacher-arranged physical activities were observed for only 2.6% of the observations, that context resulted in 16% of the intervals coded as MVPA. Similarly, portable equipment was observed

Table 3
Number of Intervals Observed and Percentage of Intervals in Intensity Levels

Observed categories	Observed codes	Observed intervals	Percentage of intervals by activity levels		
			Sedentary (Levels 1 – 2)	Light (Level 3)	MVPA (Levels 4 – 5)
Primary locations	Inside	264,809	94	5	1
	Outside	29,694	56	27	17
	Transition	10,993	61	35	4
Total observed intervals		305,560	89	8	3
Physical activity types	Sit or squat	129,974	100	0	0
	Lie down	93,571	100	0	0
	Stand	47,046	100	0	0
	Walk	21,824	0	93	7
	Run	4,461	0	0	100
	Crawl	2,209	55	41	4
	Jump or skip	1,785	1	43	56
	Climb	1,678	34	37	29
	Swing	809	36	43	21
	Dance	512	39	41	20
	Ride	421	6	78	17
	Pull or push	382	28	41	31
	Throw	294	49	33	18
	Rough and tumble	250	54	31	15
	Rock	131	44	49	8
	Roll	129	40	53	8
	Swim	12	100	0	0
Total observed intervals		305,493	89	8	3
Indoor activities	Nap	97,729	99	1	0
	Group time	46,855	96	3	1
	Transition	32,639	81	16	3
	Snack	31,714	97	3	0
	Manipulative	14,406	91	8	1
	Sociodramatic	10,751	82	15	2
	Video/screen	8,491	98	2	0
	Art	5,750	95	4	1
	Preacademic	5,700	95	5	0
	Self-care	2,985	86	13	1
	Large block	2,715	86	13	1
	Time-out	2,080	96	4	0
	Music	1,363	86	10	4
	Teacher arranged	1,193	78	14	8
	Other	318	96	4	28
	Gross motor	165	47	37	16
Total observed intervals		264,854	94	5	1
Outdoor activities	Open space	12,949	46	32	23
	Fixed equipment	9,021	64	24	13
	Ball and object	1,966	42	32	26
	Socio props	1,243	65	25	10
	Wheel	1,046	45	41	14
	Teacher arranged	789	67	17	16
	Sandbox	565	86	12	2
	Time-out	509	93	6	1
	Snacks	507	95	4	1
	Portable equipment	452	64	22	14
	Games	335	77	12	11
	Other	285	87	17	0
	Pool	18	83	17	0
Total observed intervals		29,685	56	27	17
Activity initiators	Adult initiated	246,241	94	5	1
	Child initiated	59,251	70	20	10

Table 3
Continued

Observed categories	Observed codes	Observed intervals	Percentage of intervals by activity levels		
			Sedentary (Levels 1 – 2)	Light (Level 3)	MVPA (Levels 4 – 5)
Total observed intervals		305,492	89	8	3
Group composition	Group peers only	135,288	89	8	3
	Group with adult	125,056	91	8	1
	One-to-one peer	20,898	89	7	4
	Solitary play	20,160	80	14	7
	One-to-one adult	4,058	85	13	2
Total observed intervals		305,460	89	8	3
Prompts	None	305,406	89	8	3
	Teacher increase	61	49	10	41
	Peer decrease	10	90	10	0
	Teacher decrease	4	25	25	50
	Peer increase	3	0	33	67
Total observed intervals		305,484	89	8	3

Note. MVPA = moderate to vigorous physical activity.

for only 1.5% of the intervals, but during those intervals, MVPA was recorded on 14% of the observations. Finally, and noteworthy, games were observed for only 1.1% of the observations, but when children engaged in games, 11% of the intervals were coded as MVPA.

Preschool Social Contexts

With respect to the social conditions observed across the preschool day, the initiator of activities were overwhelmingly adults, with 81% adult-initiated activities. In addition, the observed social circumstances were typically groups of children without or with teachers, and groupings constituted 85% of the observations. Finally, teachers and peers rarely prompted children to increase or decrease their physical activity during observations.

Predictors of Children's Physical Activity Outside

Given that most of the children's light physical activity (Level 3) and MVPA (Levels 4 and 5) were observed during outdoor play, we performed a series of logistic regression analyses for three outside circumstances: (a) outside activity contexts, (b) initiator of activities, and (c) group compositions and two combinations of physical activity (i.e., MVPA as Levels 4 and 5 and nonsedentary physical activity as Levels 3, 4, and 5; see Table 4).

Outdoor activity contexts. The associations between MVPA and nonsedentary physical activity and the five most common outdoor contexts were examined using logistic regression. Several low-frequency activity contexts, which constituted less than 0.05% of the outdoor observations, were not entered into the regression models (e.g., pool, snack, and time-out). When we performed a logistic regression analysis on Levels 4 and 5 during the most common outdoor activity contexts, the percentage of intervals spent in MVPA by context were (a) 26.9% of intervals with balls and objects, (b) 23.1% of intervals in open space, (c) 13.9% of intervals on fixed equipment, (d) 13.5% of intervals using wheel toys, and (e) 10.8% of intervals with sociodramatic props. When compared to sociodramatic props, MVPA was 3.21 times more likely when children were engaged with balls and objects, 2.57 times more probable when playing in open space, 1.31 times more likely when playing on fixed equipment, and 1.29 times more probable when using wheel toys. When light physical activity was added to create the percentage of intervals spent in nonsedentary physical activity during the five most common outdoor activity contexts, the percentages of intervals were (a) 58.8% of intervals with balls and objects, (b) 58.5% of intervals in open space, (c) 36.9% of intervals on fixed equipment, (d) 55.9% of intervals using wheel toys, and (e) 36.7% of intervals with sociodramatic props. Compared to sociodramatic props, nonsedentary physical activity was 2.51 times more likely when engaged in ball and object play, 2.29 times more probable when playing in open space, 1.10 times more likely when on fixed equipment, and 2.41 times more probable when using wheel toys.

Initiator of activities. During outdoor play, child-initiated activities were more frequent and associated

Table 4
Logistic Regressions for (a) Outside Activity Contexts, (b) Initiator of Activity, and (c) Group Composition[a]

	Moderate to vigorous physical activity (Levels 4 and 5)			Nonsedentary physical activity (Levels 3, 4, and 5)		
Contextual variables	Percent level	Odds ratio	95% CI	Percent level	Odds ratio	95% CI
Outdoor contexts						
Balls and objects	26.9	3.21	2.54 – 4.05	58.8	2.51	2.15 – 2.91
Open space	23.1	2.57	2.08 – 3.16	58.5	2.29	2.02 – 2.59
Fixed equipment	13.9	1.31	1.06 – 1.62	36.9	1.10	0.97 – 1.25
Wheel toys	13.5	1.29	0.96 – 1.73	55.9	2.41	2.03 – 2.87
Socio props	10.8	1.00		36.7	1.00	
Initiator of activities						
Children	19.5	1.39	1.13 – 1.67	49.4	1.55	1.37 – 1.75
Adults	15.4	1.00		43.4	1.00	
Group compositions						
Solitary	28.5	3.55	3.12 – 4.03	64.5	2.77	2.52 – 3.03
One-to-one with peer	21.1	2.29	1.99 – 2.63	49.8	1.53	1.39 – 1.69
Group without adult	19.4	2.04	1.83 – 2.20	48.3	1.48	1.38 – 1.58
Adult present[b]	11.2	1.00		40.3	1.00	

Note. CI = confidence interval.
[a]Proc Mixed on individual observations, nested within subject and center as random effects controlling for gender, age, body mass index, and ethnicity. [b]One-to-one with adult (302 intervals) and adult with group of children (4,112 intervals) combined.

with more intervals of MVPA than adult-initiated activities. Specifically, MVPA was recorded during 19.5% of the intervals that were child initiated, whereas MVPA was coded for 15.4% of the adult-initiated outdoor activities. Compared to adult-initiated activities, MVPA was 1.39 times more probable when activities were child initiated. When light physical activity was included in the analysis, 49.4% of the intervals were recorded as nonsedentary physical activity (i.e., Levels 3, 4, and 5) compared to 43.4% of adult-initiated activities. When contrasted with adult-initiated activities, nonsedentary physical activity was 1.55 times more likely when activities were child initiated.

Group compositions. During outdoor play periods, children were observed in several social groupings including (a) solitary, (b) one-to-one with peer and no adult present, (c) two or more peers without adult present, and (d) adult present with focal child or focal child and peers. Specifically, MVPA was coded on (a) 28.5% of the intervals in which children were solitary, (b) 21.1% of the intervals when they were one-to-one with a peer, (c) 19.4% of the intervals when they were involved with two or more peers without adult, and (d) 11.2% of the intervals when adults were present with focal child or focal child and peers. Compared to outdoor activities with adults present, MVPA was 3.55 times more likely if children were alone, 2.29 times more probable when one-to-one with another peer, and 2.04 times more likely when the focal child was in a group of peers. Analysis of nonsedentary physical activity (i.e., Levels 3, 4, and 5) resulted in (a) solitary child with 64.5% of intervals, (b) one-to-one with a peer with 49.8% of intervals, (c) two or more peers without adult with 48.3% of intervals, and (d) adult present with focal child or focal child and peers with 40.3% of intervals. Compared to activities with an adult present, nonsedentary physical activity was 2.77 times more probable when children were alone, 1.53 times more likely when one-to-one with a peer, and 1.48 times more probable when with two or more peers without adults.

Discussion

The ''conventional wisdom'' (cf. Galbraith, 1958) of many early childhood educators is that young children are very active in preschools. Nevertheless, researchers with accelerometry and direct observation have shown that, most often, young children's physical activity in preschools is primarily sedentary in nature (for review, see Oliver et al., 2007). For example, with the same sample of preschoolers, Pate et al. (2008) found that even after removing nap time observations from their analysis, MVPA was observed during only 3.4% of the observations throughout the preschool day. Furthermore, findings from

a three-way analysis of variance (gender, race, and age group) indicated that 4- and 5-year-old children had more sedentary activity and engaged in less frequent light physical activity and MVPA than 3-year-old children. In addition, males were more active than females for the total sample. In particular, 3-year-old males were more active than 4- and 5-year-old children were, but this activity difference was not obtained for females. The age and gender associations may have some implications on the types of physical activities teachers provide and encourage on preschool playgrounds. Nevertheless, multiple ''gender-neutral activities,'' especially for young boys and girls with teacher support and encouragement, exist and those activities might be embedded into preschool circumstances throughout the day (e.g., running, soccer, and dancing). Moreover, we believe that practitioners should not restrict young children's emerging skills and dispositions about various physical activity types and formats. Rather, they should be identifying multiple options that allow for individualization and choices to engage in enhanced physical activity that are not necessarily gender related in the sociological sense.

Our recent direct observation results replicate the findings of investigators who have reported low levels of preschoolers' MVPA in center-based programs, even during outdoor play. Nevertheless, our findings make available more comprehensive behavioral and contextual information for a sample of preschoolers' physical activity than previous investigations. This detailed assessment of children's preschool *milieu* allows for analyses of the moment-to-moment circumstances associated with physical activity. For example, the overwhelming majority of both children's physical activity levels and their physical activity types were sedentary in nature during most of the preschool day. Even during outdoor play, our observations indicated that most often children's activities were sedentary (i.e., 56% sedentary vs. 27% light vs. 17% MVPA) and that teachers very rarely used intentional methods such as encouragement to be physically active and teacher-arranged activities to increase physical activity. We believe the low levels of children's activity and the lack of adult encouragement of their physical activity point to a need for teacher involvement to enhance preschoolers' activity levels.

With respect to circumstances related to preschoolers' physical activity outside, our analyses also provided information about contexts that may set the occasion for enhanced nonsedentary physical activity and MVPA. Given the five most common activity contexts, balls and other play objects and the provision of open space were much more likely to be associated with nonsedentary physical activity and MVPA. Our findings are similar to Bower et al.'s (2008) results with assessment of preschool physical and social features that were related to enhanced physical activity and decreased sedentary behavior. If one's goal is to increase children's physical activity while decreasing their sedentary behavior, careful attention to the availability of particular outdoor materials and sufficient open space, which are associated with preschoolers' opportunities for physical activity, may be warranted.

With regard to initiator of activities, high-level physical activity was more likely when children initiated the outside activities. In addition, examination of the social groupings on playgrounds showed that preschoolers were more likely to be involved in nonsedentary physical activity and MVPA when adults were not present or involved with the immediate group and activity context. Given the initiator and group findings, some may question our call for adult involvement to enhance children's activity levels on playgrounds. Although we acknowledge the robust relationships for child-initiated activities and limited teacher involvement for preschoolers' physical activity under ''business as usual conditions'' in the observed preschools, two points are noteworthy with respect to teacher presence and involvement. First, under common playground circumstances, the majority of physical activity was sedentary in nature (i.e., 56%). Second, even when teachers were present, they rarely if ever implemented teacher-arranged activities to enhance children's physical activity or encouraged children's physical activity. Hence, when adults were present, they were often not involved in children's physical activities. Our anecdotal observations in preschools indicate that many teachers are relatively passive with respect to encouragement and participation in children's physical activities during outdoor play. Moreover, our previous observations (e.g., Pate et al., 2004) as well as other investigators' efforts (e.g., McKenzie et al., 1997; Sallis et al., 1988) confirm those perceptions of adult behavior on playgrounds. Descriptive findings about ''business as usual conditions'' in preschools may be very different, however, from the important notion of what might be important to children's healthy physical activity. Hence, if a goal of outdoor play is children's enhanced physical activity (cf. Council on Sports Medicine and Fitness and Council on School Health, 2006; Pellegrini & Smith, 1998), especially for brief but intensive bouts of MVPA (Brown, Googe, McIver, & Rather, in press), then intentional and active adult

involvement ''ought'' (in the philosophical sense) to be integrated into children's recesses.

We realize that adult involvement is multifaceted, complex, and at times a controversial issue among many early childhood educators. Nevertheless, active adult involvement may be an especially important factor for additional enhancement of children's physical activity in preschools (cf. Bower et al., 2008; Brown et al., in press). For example, although our observations showed that teacher-arranged physical activities and games outdoors are infrequent, when these two activity contexts did occur, they resulted in relatively high proportions of children's MVPA. What we are advocating is not interference with children who are already very physically active. Rather, given the extant information on preschoolers' limited physical activity, we believe that strategic adult involvement by organizing, modeling, encouraging, and acknowledging children's physical activity with a goal of preschoolers becoming more active may be warranted for many children.

Strengths and Limitations of the Study

Our descriptive approach had several strengths including (a) a relatively large and ethnically and economically diverse sample of participants, (b) cross-sectional data with two waves of collection in 24 community-based preschools, and (c) reliable direct observation information systematically collected across children, preschool circumstances, and days. Nevertheless, the present investigation has several limitations common to gathering physical activity data, particularly direct observation information. First, we purposefully constrained our sample to community-based preschools not affiliated with public schools. Second, although we randomly solicited participation from a stratified sampling frame of community-based preschools, the resultant study sample was restricted to consenting administrators and children who had parental permission and who were enrolled in the accepting programs. Hence, although we replicated physical activity findings with a relatively large and diverse sample, the results may be limited with respect to generalizability, especially to children in public schools. Third, we employed a momentary time sampling strategy to collect the observational information. Although the approach yielded two reliable, observational estimates every minute for each 30-min observation across 5–6 hr, the method does not provide ''real-time'' data for children's physical activity or associated contextual conditions. Past experiences with complex coding systems have indicated that to collect real-time information on preschoolers in situ with multiple codes will either significantly decrease the reliability of observations or in the case of videotapes increase the ''observational burden'' for investigators (cf. Brown, Odom, Li, & Zercher, 1999). Moreover, the time sampling we employed does not readily allow for straightforward extrapolations of the amount of time related to children's physical activity across the day. Those types of physical activity time estimations are better matched to more objective and calibrated accelerometry measures (cf. Oliver et al., 2007).

Implications for Early Childhood Policy Makers and Practitioners

In two studies, Pate and colleagues (Pate et al., 2004; Pate et al., 2008) have found that the particular preschool children attended accounted for more variance in their physical activity than individual child variables including gender, ethnicity, and age, which have been associated with children's physical activity. Moreover, the finding has been replicated by other investigators (e.g., Bower et al., 2008; Finn et al., 2002). As mentioned, with the sample in the present study, Pate et al. (2008) determined that the particular preschool accounted for more variability in children's activity (i.e., nonsedentary activity and MVPA yielded R^2s of .37 and .22, respectively) than children's ethnicity, gender, and age.

Because investigations of well-specified factors that might influence children's physical activity in preschools have been limited, future inquiry into which preschool characteristics are related to preschoolers' physical activity may be important for policymakers and practitioners. To our knowledge, only two examples of careful analyses have been published (Bower et al., 2008; Dowda, Pate, Trost, Almeida, & Sirard, 2004). First, Dowda et al. (2004) found that children in higher quality preschools, as indicated by higher Early Childhood Environmental Rating Scales–Revised (ECERS–R) scores (i.e., > 5 on 7-point Likert scale), had more observed intervals of MVPA than children in programs with relatively lower quality ECERS–R ratings (i.e., < 5 on 7-point Likert scale). In addition, the investigators determined from administrator and teacher interviews that children in preschools that had more resources (i.e., provided field trips, and college-educated teachers) had increased MVPA. With children in CHAMPS, preliminary analyses have again indicated that children in programs with higher ECERS–R ratings had fewer intervals of sedentary activity and more intervals light, moderate, and vigorous physical activity than children in programs with lower ECERS–R

ratings (Dowda, Brown, McIver, Pfeiffer, & Pate, 2008). Recently, Bower et al. (2008) assessed setting characteristics related to children's physical activity in 20 preschools with the Environment and Policy Assessment and Observation (EPAO) instrument. They found that preschoolers served in supportive settings as indicated by the EPAO had (a) more intervals of MVPA, (b) fewer intervals in sedentary activity, and (c) higher average physical activity levels. Salient physical and social dimensions related to children's physical activity of supportive preschools included (a) opportunities for activity, (b) portable play equipment, (c) fixed play equipment, and (d) teachers' physical activity training and education.

From the existing evidence, we conclude that variation in day-to-day policies and practices in preschools may be especially important to a better understanding of children's sedentary and nonsedentary physical activity. Specifically, we believe that policymakers and practitioners need to become better informed about preschoolers' general health and physical well-being, particularly with respect to the nature of young children's physical activity. Contemporary professional standards for young children's physical activity have been propagated by the National Association for the Education of Young Children (1998), which recommends at least 60 min of outdoor activity per day, and the National Association for Sport and Physical Education (2002), which advises 120 min per day of physical activity (i.e., 60 min structured and 60 min unstructured) for young children. Because children's health and physical well-being constitute an important developmental dimension, we believe along with many public health (e.g., Biglan, 2004; Goodway & Smith, 2005) and early childhood education (e.g., Brown et al., in press; Scott-Little & Kagan, 2006) professionals that enhanced rates of nonsedentary physical activity are needed to promote preschoolers' healthy lifestyles, particularly for preschoolers who are growing up in low-income families and who are at greater risk for poor health outcomes. Given that many young children are presently served for substantial periods in community- or school-based programs, these settings should be especially important for interventions to influence positively preschoolers' present and future healthy lifestyles (cf. Bandura, 2004; Pate et al., 2004).

In the "age of accountability," early childhood educators have become focused on children's school readiness skills (e.g., No Child Left Behind Act of 2001). Unfortunately, given the education *zeitgeist* and a relatively low level of importance assigned to children's motor development and physical activity relative to school readiness skills as indicated by contemporary early learning standards (cf. Scott-Little & Kagan, 2006), preschool policies and practices may not be well aligned with a significant public health issue. Hence, we believe that additional emphasis should be placed on young children's physical activity and motor development. Nevertheless, we do not view policies and practices focused on physical activity and motor development as an "either–or" issue. Indeed, high-quality early childhood education should concentrate on all critical developmental areas. Fortunately, broader early childhood goals are not necessarily mutually exclusive with high-quality preschools as indicated by Dowda et al.'s (2004) findings with relatively higher ECERS–R ratings associated with enhanced levels of physical activity. We are not advocating that educators reduce their efforts to address children's language, preacademic, and social emotional developmental needs. Nevertheless, along with public health (e.g., Centers for Disease Control and Prevention, 2004) and early childhood education professionals (e.g., Krishnamoorthy et al., 2006), we believe that policy makers and practitioners need to deal with health issues and explicitly integrate appropriate health-related activities throughout the preschool day.

Implications for Researchers

Given existing information about preschool children's physical activity, additional careful descriptive analyses of the contextual and behavioral factors associated with their activity might allow investigators to plan better and evaluate effective, practical, and preventive programs to promote healthy activity in preschools (cf. Brown et al., in press). Moreover, given the replicated finding that the particular preschool children attend is a predictor of their physical activity, the careful analyses of which day-to-day preschool policies and practices relate to enhanced physical activity awaits additional research (cf. Bower et al., 2008; Dowda et al., 2004; Pate et al., 2004; Pate et al., 2008). Until such applied research information is forthcoming, day-to-day teacher planning, implementing, and embedding of high-interest activities that promote children's nonsedentary physical activity throughout the preschool day appear to be curricular areas sorely in need of development and evaluation. To date, only limited information exists about appropriate preschool activities that might enhance young children's physical activity and motor development (cf. Brown et al., in press; Pate, 2001). For example, Goodway and Branta (2003) demonstrated with twice-weekly motor

development and physical activity sessions across 12 weeks that preschoolers improved their locomotor and object control skills. Recently, Brown et al. (in press) showed that teacher implementation of two high-interest outdoor activities, ''Track Team'' (i.e., group running) and ''Dance Party'' (i.e., group dancing), systematically increased preschoolers' MVPA for short albeit sustained periods during intervention and those augmented activity levels were well above the those common when teachers perform their typical playground responsibilities. Hence, intentional teacher activities might well be an avenue for enhancing children's physical activity for brief periods during their preschool day.

We believe that an emerging area of much-needed applied research is how to develop, disseminate, and diffuse evidence-based physical activity interventions to early childhood educators (cf. Owen, Glanz, Sallis, & Kelder, 2006; Pate, 2001). Similar to other areas of investigation, the development, evaluation, and dissemination of physical activity interventions might benefit from systematic lines of inquiry. Such lines of investigation should evolve from small-scale studies to develop effective, acceptable, and feasible practices followed by large-scale investigations with manuals and materials for dissemination of information in a manner that enhances the likelihood that practitioners will employ the procedures in preschools (cf. Weisz, Jensen, & McLeod, 2004).

With elementary-school-aged children, some evidence exists that their physical activity patterns are related to subsequent adolescent physical activity (e.g., Thompson, Humbert, & Mirwald, 2003). In addition, in a recent survey of elementary school administrators and teachers, Parks, Solmon, and Lee (2007) found favorable attitudes about children's physical activity in schools and that the responding practitioners may be willing to integrate physical activities into their schedules. Although speculative at this time, additional opportunities for young children to participate in high-interest and healthy physical activities, particularly regular activities with age-appropriate and teacher-guided discussions that emphasize the importance of the activities, may promote children's nascent positive health behaviors and attitudes that may influence their later physical activity patterns and health status (cf. Bandura, 2004). In the future, the ultimate efficacy, effectiveness, generalizability, and sustainability of well-planned preventive physical activity programs with young children and early childhood practitioners in community- and school-based programs may be a particularly productive and challenging area of investigation for early childhood education and public health researchers.

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