Preschool Environmental Influences on Physical Activity in Children with Disabilities

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ABSTRACT

SCHENKELBERG, M. A., K. L. MCIVER, W. H. BROWN, and R. R. PATE. Preschool Environmental Influences on Physical Activity in Children with Disabilities. *Med. Sci. Sports Exerc.*, Vol. 52, No. 12, pp. 2682–2689, 2020. **Purpose:** The purpose of this study was to describe associations between physical and social environmental features of preschools and physical activity behaviors of young children with developmental disabilities. **Methods:** A sample of 34 preschool-age children (mean age, 4.28 ± 1.07; male, 64.7%) with developmental disabilities participated in this study. Physical activity and preschool environmental factors were measured through direct observation using the Observational System for Recording Physical Activity in Children—Developmental Disabilities version. Children were observed approximately eight times over the course of a week, yielding a total of 11, 310 observation intervals. The number of intervals and percentage of time spent in physical activity across environmental contexts were calculated. Logistic regression analyses were conducted to determine associations between time spent in physical activity and features of the physical and social environment. **Results:** Children with disabilities were sedentary for most of the observed intervals (81.5%). Children were 4.8 times (confidence interval (CI), 4.25–5.50) more likely to be physically active while outdoors compared with indoors. Physical activity was more likely to occur in open spaces (odds ratio [OR], 3.3; CI, 2.59–4.19) and when using portable play equipment (OR, 2.7; CI, 1.31–5.64) compared with fixed playground equipment. While indoors, children in this study were 5.6 times (CI, 3.78–8.03) more likely to be active when in therapy compared with group time activities. Physical activity was more likely to occur when in solitary (OR, 3.4; CI, 2.87–4.10) or one-on-one group contexts (OR, 1.7–2.9) compared with in groups with an adult present. **Conclusions:** Certain features of the preschool setting, such as location and social group composition, were more conducive to physical activity than others. Children with disabilities would benefit from more time outdoors and in smaller group settings during preschool. **Key Words:** CHILD CARE CENTERS, DEVELOPMENTAL DISABILITIES, AUTISM SPECTRUM DISORDER, YOUNG CHILDREN

In the United States, the prevalence of children with diagnosed developmental disabilities (e.g., autism, intellectual disability, Down syndrome, cerebral palsy) has increased in recent years, affecting approximately one in six children (1,2). These children are at greater risk for chronic health conditions, and they experience impairments in communication, learning, mobility, and self-care that persist into adulthood (3). In spite of these impairments, regular participation in physical activity may aid in the prevention of chronic health conditions and can also positively affect cognitive and behavioral skills (4–6). Improving participation in physical activity during the early childhood years can result in significant health and developmental benefits (7,8). The *2018 Physical Activity Guidelines for Americans* recommends that young children (age 3–5 yr) accumulate at least 3 h of light, moderate, and vigorous physical activity each day through structured and unstructured play (9). Despite this recommendation, physical activity levels are low among young children with and without disabilities (10–12). Half of typically developing 3- to 5-yr-olds meet the physical activity guidelines (12), and although these data are not available for young children with disabilities, a recent study has indicated that only 19% of 6- to 17-yr-olds with developmental disabilities achieve recommended levels of physical activity (13). Furthermore, children with disabilities have been observed to be less active compared with typically developing peers (11,14).

Approximately 60% of 3- to 5-yr-old children in nonparental childcare arrangements attend a center-based program, hereafter referred to as preschools, for an average of 23 h·wk^{-1} (15,16). Similarly, those with disabilities spend a substantial amount of time in these settings and receive special education services under the Individuals with Disabilities Education Act (17). In a recent study, Costanzo and Magnuson (17) analyzed nationally representative data and found that approximately 36% of children with disabilities attend center-based preschool programs and that this rate is higher among children with multiple diagnoses. Given the amount of time children spend in preschool settings and the potential reach, preschool settings are uniquely positioned to provide opportunities for physical activity participation for young children with disabilities.

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Previous studies have demonstrated that the preschool a child attends accounts for a significant amount of the variance in daily physical activity (18,19). This variability may be related to the policies and practices within preschools (20). It may also be attributed to the numerous behavior settings, in which children interact during the preschool day (21). Behavior settings are described as ecological units bound by space and time within which people and the environment interact, resulting in patterns of behavior (21,22). Within preschool behavior settings, such as group time, outdoor play, and center activities, children interact with features of the physical and social environment, consequently affecting physical activity levels. For example, it is well known that preschoolers are more active when they are outdoors compared with indoors (23,24). Cosco et al. (21) more closely examined the preschool outdoor environment and found that most physical activity occurred in four specific behavior settings: open areas, sand play, pathways, and fixed equipment. Other studies have observed higher levels of physical activity during child- versus adult-initiated playground activities and in smaller social group contexts (23,25).

Emerging evidence suggests that the physical activity behaviors of young children with developmental disabilities are also influenced by physical and social environmental features of behavioral settings. During free play at a summer camp, children with autism were found to be significantly more active when solitary compared with when in social groups (26). School-age children with developmental disabilities have been observed to be less active in structured physical education settings compared with free play, and this varied by lesson context (27,28). Nonetheless, there is a significant gap in the literature regarding the physical activity behaviors of preschoolers with disabilities and how features of the preschool environment associate with their physical activity behaviors. Therefore, the purpose of the present study was to describe associations between physical and social environmental features of preschools and physical activity of young children with developmental disabilities.

METHODS

Participants and Setting

Participants were recruited from a convenience sample of preschools (n = 5) in a southeastern state, and data collection occurred in the spring (average temperature, 69°F). Children were enrolled in inclusive or special education classrooms comprising a lead teacher, one or two assistant teachers, and approximately 10 children. Children were excluded from the study if they did not have a formal developmental disability or delay diagnosis from a health care professional (as described hereinafter), had significant physical or medical impairments that hindered movement, and did not attend preschool at least 3 $d \cdot wk^{-1}$. Parents and guardians of 38 ambulatory children (ages 3–5 yr) consented to the study; however, 4 were excluded because of the absence of a formal diagnosis. Most children were enrolled in a special education preschool classroom (94.1%) and had more than one diagnosis. Primary diagnoses for the 34 participating children (64.7% male; mean age, 4.28 ± 1.07 yr) included autism (47.1%), general developmental and learning delays (23.5%), Down syndrome (20.6%), and other disabilities (8.8%). Demographic characteristics of the sample are summarized in Table 1. This cross-sectional study was approved by the University of South Carolina Institutional Review Board, and families received a modest incentive for participating in the study.

Measures

Demographics. Upon consent, parents and guardians completed a brief demographic survey. Parents reported their child's birthdate, sex, race, diagnosis, special education and therapy services, and daily living skills. Questions about diagnosis, special education and therapy services, and daily living skills were selected from the 2009–2010 National Survey of Children's Health with Special Health Care Needs (29). Parents reported the type of health care provider that diagnosed their child and selected the specific developmental disability or delay diagnoses from a list of 12. For special education services, parents reported whether their child received early intervention services through an Individualized Family Service Plan and if these services began before age 3 yr. Parents also indicated if, at the time of the study, their child received special education services through an Individualized Education Plan, and regular physical, speech, occupational, or other therapy such as cognitive behavior therapy, applied behavioral analysis, or social skills therapy. Lastly, parents reported their race, marital status, and level of education.

Adaptive behavior skills. Adaptive behavior skills are skills that are necessary to be autonomous in daily life and are acquired as children develop (30). Evaluating adaptive

TABLE 1. Demographic characteristics and physical activity levels of study participants.

	Total
n	34
Age, mean ± SD, yr	4.28 ± 1.07
Sex, % male (*n*)	64.71 (22)
Race/Ethnicity, % (*n*)	
White	50.00 (17)
Black/African American	32.35 (11)
Hispanic/Latino white	8.82 (3)
Other or more than one race	8.82 (3)
Diagnoses, % (*n*)	
Autism	47.1 (16)
Developmental and learning delays	23.5 (8)
Down syndrome	20.6 (7)
Other	8.8 (3)
ABC, mean ± SD	68.83 ± 11.32
Vineland summary scores, mean ± SD	
Daily living skills	69.93 ± 9.10
Communication skills	63.13 ± 20.17
Social skills	75.30 ± 11.64
Motor skills	73.53 ± 11.37
Level of impairment, % (*n*)	
Less impaired	46.67 (14)
More impaired	53.33 (16)
Parent education status, % (*n*)	
High school or less	20.59 (7)
Associates or college	70.59 (24)
Graduate school or above	8.82 (3)

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behaviors provides an age-equivalent score of the functional status of the individual. In the present study, a trained investigator administered the Vineland Adaptive Behavior Scale, Third Edition (VABS-3) (30) as a semistructured interview with parents and guardians in order to assess participants' degree of impairment. The VABS-3 is a standardized instrument that is used to evaluate adaptive behavior skills from birth to age 90 yr across several key domains including the following: communication skills, socialization skills, daily living skills, motor skills, and maladaptive behaviors (30). Standard scores from the communication, socialization, and daily living skills domains are summed to produce an Adaptive Behavior Composite (ABC) score, which describes overall level of functioning.

Observational System for Recording Physical Activity in Children—Developmental Disabilities. The Observational System for Recording Physical Activity in Children—Developmental Disabilities version (OSRAC-DD) was used to assess physical activity behaviors in children with disabilities (31). This instrument allows for the simultaneous assessment of physical activity levels, types of activity, and presence of repetitive/stereotypic behaviors across preschool physical and social environmental contexts. Details of the OSRAC-DD development and evaluation process are described elsewhere (31). Briefly, this instrument includes valid and reliable codes from several observation instruments: Children's Activity Rating Scale (CARS) (32), the Observational System for Recording Activity in Children—Preschool (OSRAC-P) version (33), and the Individual Child Engagement Record—Revised version (34). Additional codes (e.g., therapy context, repetitive/stereotypic behavior) were added to enhance the content validity of the instrument for use among children with disabilities (31). For example, informal observations during the OSRAC-DD development phase revealed that children frequently attended therapy sessions during the preschool day, so this code was added as a specific context (31). Individuals with disabilities, particularly autism, often demonstrate repetitive/stereotypic behaviors such as body rocking, stimming, and hand flapping, which are thought to contribute to overall levels of physical activity (6,10). Therefore, a repetitive/stereotypic behavior category and corresponding codes were also included in the OSRAC-DD (31).

Physical activity level codes and methodology in the OSRAC-DD were drawn from the CARS and the OSRAC-P (32,33) and were recorded on a scale of 1 to 5. Level 1 was stationary, level 2 was stationary with limb movement, level 3 was slow movement, level 4 was moderate movement, and level 5 was vigorous movement. These codes were developed and validated for young children without disabilities (32); however, one study has investigated the psychometric properties of the codes for individuals with intellectual disabilities (35). Eleven ambulatory children (ages 6–14 yr; mean, 10.5 ± 2.5 yr) with diagnosed intellectual disabilities participated in the study. Physical activity during gym activities was concurrently assessed using the CARS observation protocol and Actiwatch accelerometer, and results indicated that CARS scores were moderately correlated with criterion-derived physical activity estimates ($r = 0.61$) (35).

In addition to physical activity levels, preschool physical and social environmental contexts were simultaneously recorded using the OSRAC-DD. Physical environment categories included location, indoor education/play context, and outdoor/gym education/play context. Social environment categories included activity initiator, group composition, interaction, and prompts for physical activity. Most of the physical and social environment categories and codes were adopted from the OSRAC-P (33), but some were specific to the OSRAC-DD in order to reflect contexts and circumstances unique to children with disabilities, such as therapy and interactions with therapists (31). Interaction codes were adopted from the Individual Child Engagement Record—Revised, a valid and reliable instrument for evaluating interaction and engagement of children with disabilities in early childhood settings (31,34).

Procedures

Before data collection, preschool teachers from participating classrooms provided the research team with a copy of their classroom's typical daily schedule (e.g., start and end times, nap times, mealtimes). After receiving parental consent forms, the research team developed an observation schedule to ensure that children were observed across a variety of preschool behavior settings throughout the day. The research team visited each preschool for five consecutive days during the data collection period. Following a focal-child, momentary time-sampling protocol, trained observers completed 8 to 10 randomly assigned observation sessions per child. Nap and lunch times were excluded from observations. Observation sessions were 20 min in duration and comprised 30-s coding intervals. Each 30-s coding interval consisted of a 5-s observation followed by a 25-s recording interval. These coding intervals repeated continuously across observation sessions, yielding two coding intervals per minute. Data were entered into tablet computers using the LILY data collection software (36). Observers wore headphones and listened to audio prompts to indicate the 5-s observation and 25-s record periods. At the end of the 5-s observation period, observers recorded the highest level of physical activity followed by the corresponding physical and social environmental context codes.

The OSRAC-DD observations were conducted by two trained observers who had backgrounds in exercise science and had previously worked with young children with disabilities. Observer training followed the eight steps described by Brown et al. (33) and included informal observations, memorizing codes, definitions, and protocol, debriefing sessions, and *in situ* observations. The study began after observers achieved at least 80% agreement on all coding categories during *in situ* observations. Interrater reliability was assessed during 40 observation sessions over the course of the study. Observers listened to audio prompts through split headphones to simultaneously but independently record the same focal child's physical activity behaviors and environmental contexts. Interrater reliability was determined by calculating percent agreement and Cohen κ for each observation category. Percent agreement ranged from 82% to 99%, and κ values ranged from 0.77 to 0.99 indicating adequate reliability across all categories (Table 2).

TABLE 2. Average κ coefficients and interobserver percent agreement by OSRAC-DD coding category.

	Mean	SD
Physical activity level		
κ	0.77	0.12
Percent agreement	0.82	0.11
Physical activity type		
κ	0.90	0.09
Percent agreement	0.90	0.09
Stereotypic/maladaptive behavior		
κ	0.96	0.08
Percent agreement	0.96	0.08
Location		
κ	0.99	0.03
Percent agreement	0.99	0.02
Indoor activity context		
κ	0.95	0.09
Percent agreement	0.95	0.09
Outdoor activity context		
κ	0.98	0.04
Percent agreement	0.98	0.04
Activity initiator		
κ	0.95	0.12
Percent agreement	0.97	0.08
Group composition		
κ	0.89	0.11
Percent agreement	0.90	0.08
Interaction		
κ	0.77	0.19
Percent agreement	0.89	0.07
Prompts		
κ	0.95	0.20
Percent agreement	0.99	0.03
Reactivity		
κ	0.98	0.04
Percent agreement	0.98	0.04

Analysis

Descriptive statistics were calculated for participant characteristics and are presented in Table 1. VABS-3 qualitative descriptors were applied to ABC scores and motor skill scores to classify the level of impairment (30). Children with scores of greater than 70 were considered "less impaired," and those with scores less than or equal to 70 were considered "more impaired." Physical activity levels, as determined by the OSRAC-DD, were aggregated into four different levels of intensity: sedentary (levels 1 and 2), light (level 3), moderate-to-vigorous (MVPA; levels 4 and 5), and total physical activity (TPA; levels 3, 4, and 5). The number and percentage of intervals spent in sedentary, light, and MVPA were calculated across physical and social environmental contexts and are presented in Table 3. Pearson χ^2 analyses were conducted to determine differences in MVPA and TPA by sex, age (younger, ≤4.5 yr; older, ≥4.5 yr), race, diagnosis, level of overall impairment, and level of motor impairment.

Logistic regression analyses were conducted using the PROC GLIMMIX program in SAS Studio 3.71 Release (SAS Institute, Inc., Cary, NC). Observation intervals were used as the unit of analysis, and child nested within school were included as random effects. Separate models were conducted for 1) repetitive/stereotypic behaviors, 2) location, 3) indoor education/play context, 4) outdoor/gym education/play context, 5) activity initiator, and 6) group composition and interaction. All models were adjusted for age, sex, diagnosis, and motor skill level.

RESULTS

Participating children were observed for an average of 332.9 ± 27.4 coding intervals per child, corresponding to approximately 166.5 min of observation per child. In total, children were observed for 11,310 coding intervals. Overall, for 81.5% of observed intervals, the children's activity level was rated as sedentary, 16.1% were rated light physical activity, and 2.4% were rated MVPA. Children were observed to spend nearly 50% of the time in sitting, standing, and walking behaviors and rarely engaged in more vigorous movements such as running, jumping or skipping, and dancing. Repetitive, stereotypic behavior occurred during 5.3% of observed intervals (Table 3).

Preschoolers with disabilities in this study spent most of the time indoors (79.6%), and nearly 88% of time indoors was observed to be sedentary with less than 1% of the time spent in MVPA. Excluding snack contexts, group time, transition, manipulative play, therapy, and sociodramatic play were the top 5 most frequently occurring indoor contextual circumstances. Children were primarily sedentary in these settings (range, 71.3%–93.6%), and TPA occurred between 6.4% and 28.7% of the time. Approximately 18.1% of observed intervals occurred outdoors. Overall, preschoolers with disabilities were observed to be in light and MVPA 30.9% and 9.2% of the time while outdoors, respectively. The most frequently occurring outdoor contexts were fixed equipment (46.4%), open space (30.6%), wheel (8.2%), ball (6.1%), and portable play equipment (2.8%).

Regarding the social environment, most of the observed activities that preschoolers with disabilities engaged in during the day were adult initiated (59.7%). Children with disabilities initiated physical activity approximately 40.2% of the time (Table 3). Across all behavior contexts, children spent 58.7% of the time in a group setting and were one-on-one with a therapist or other adult for 24.5% of the observed intervals. Within these social group contexts, children interacted with others during 37.1% of intervals and were physically prompted by a peer or adult during 6.5% of intervals. Verbal prompts to increase or decrease physical activity rarely occurred (1%).

Independent associations between demographic variables and percentage of intervals spent in MVPA and TPA were investigated. There were no differences in MVPA or TPA across groups formed on the basis of sex ($\chi^2_{mvpa}(1, 11{,}036) = 2.8$, $P = 0.09$; $\chi^2_{tpa}(1, 11{,}036) = 0.6$, $P = 0.45$), age ($\chi^2_{mvpa}(1, 11{,}036) = 0.7$, $P = 0.42$; $\chi^2_{tpa}(1, 11{,}036) = 0.7$, $P = 0.39$), race ($\chi^2_{mvpa}(1, 11{,}036) = 0.0$, $P = 0.96$; $\chi^2_{tpa}(1, 11{,}036) = 0.3$, $P = 0.59$), diagnosis ($\chi^2_{mvpa}(1, 11{,}036) = 3.5$, $P = 0.06$; $\chi^2_{tpa}(1,$

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TABLE 3. Number of observed intervals and percentages observed in sedentary, light, and MVPA by OSRAC-DD category.

Categories, Observed Codes	Observed Intervals	Sedentary	Light	MVPA
Total observed intervals	11,310	81.45	16.14	2.40
Location				
Inside	8809	87.98	11.15	0.87
Outside	1999	59.93	30.87	9.20
Transition	262	26.34	71.76	1.91
Physical activity type				
Sit/squat	6099	99.84	0.16	0.00
Stand	2446	99.02	0.94	0.04
Walk	1526	0.26	94.43	5.31
Lie down	329	99.70	0.30	0.00
Swing	164	55.49	30.49	14.02
Jump/skip	109	0.92	47.71	51.38
Crawl	99	28.28	69.70	2.02
Run	85	0.00	0.00	100.00
Ride	78	11.54	79.49	8.97
Climb	30	6.67	86.67	6.67
Pull/push	28	32.14	50.00	17.86
Rock	26	50.00	50.00	0.00
Dance	23	17.39	65.22	17.39
Throw	21	57.14	42.86	0.00
Other	4	100.00	0.00	0.00
Rough and tumble	3	33.33	66.67	0.00
Repetitive/stereotypic behavior				
None	10,480	81.87	15.88	2.25
Object	212	89.62	9.91	0.47
Motor	313	62.62	30.35	7.03
Vocal	65	78.46	10.77	10.77
Indoor education/play contexts				
Group time	1899	93.63	5.11	1.26
Transition	1337	71.28	26.85	1.87
Snacks	1224	98.94	1.06	0.00
Manipulative	1172	87.46	12.03	0.51
Therapy	1150	80.26	18.43	1.30
Sociodramatic	670	88.36	11.04	0.60
Books/preacademic	429	94.64	5.36	0.00
Videos	297	95.29	4.38	0.34
Large blocks	151	87.42	12.58	0.00
Teacher arranged	112	88.39	9.82	1.79
Art	108	98.15	1.85	0.00
Music	79	97.47	2.53	0.00
Self-care	74	95.95	4.05	0.00
Gross motor	39	74.36	25.64	0.00
Other	35	94.29	5.71	0.00
Time out	32	96.88	3.13	0.00
Outdoor/gym education/play contexts				
Fixed	925	69.30	23.57	7.14
Open space	611	45.66	39.44	14.89
Wheel	164	54.27	38.41	7.32
Ball	122	52.46	38.52	9.02
Portable	55	69.09	30.91	0.00
Teacher arranged	43	53.49	39.53	6.98
Socioprops	29	68.97	31.03	0.00
Snacks	18	100.00	0.00	0.00
Time out	18	100.00	0.00	0.00
Sandbox	9	66.67	33.33	0.00
Activity initiator				
Adult initiated	5194	88.66	10.40	0.94
Child initiated	4455	74.12	21.44	4.44
Therapist initiated	1416	78.25	20.55	1.20
Peer initiated	5	40.00	20.00	40.00
Group composition				
Group adult	5729	85.97	12.15	1.89
1–1 adult	1603	80.47	18.47	1.06
1–1 therapist	1114	74.06	24.51	1.44
Solitary	1070	72.90	21.68	5.42
1–1 peer	786	80.03	17.18	2.80
Group peer	768	73.96	20.18	5.86
Interaction				
No interaction	6242	84.25	13.06	2.69
Interaction with adult	1385	80.00	18.92	1.08
Interaction with group	1230	80.33	16.50	3.17
Interaction with therapist	895	75.42	22.91	1.68
Physical prompt	716	72.91	26.54	0.56
Interaction with peer	601	77.20	18.64	4.16
Prompts				
No prompt	10,955	81.85	15.82	2.33
Therapist prompt—increase	68	36.76	52.94	10.29
Teacher prompt—increase	41	56.10	34.15	9.76
Teacher—prompt decrease	3	33.33	66.67	0.00
Peer prompt—increase	1	0.00	100.00	0.00

11,036) = 0.9, P = 0.34), or level of impairment (χ^2_{mvpa}(1, 9768) = 0.3, P = 0.60; χ^2_{tpa}(1, 9768) = 0.9, P = 0.35). Compared with children with greater motor skill impairments, children who were less impaired in motor skills spent more time in MVPA (χ^2_{mvpa}(1, 9768) = 8.0, P = 0.005). This finding did not hold for TPA (χ^2_{tpa}(1, 9768) = 0.4, P = 0.53).

A series of logistic regression analyses were calculated for each physical and social environmental context with TPA as the dependent variable. All models controlled for age, sex, diagnosis, and motor skill level, and results are presented in Table 4. After controlling for covariates, preschoolers with disabilities were 1.8 times more likely to engage in TPA while performing repetitive or stereotypic behavior. Children with disabilities were 4.8 times more likely to engage in physical activity when outdoors compared with indoors. Compared

TABLE 4. Logistic regression analyses for environmental contexts and TPA among preschoolers with disabilities.

	TPA		
	% Level	OR	95% CI
RSB			
Any RSB	24.92	1.78	1.46–2.17
No RSB	17.44	1.00	
Location			
Outside	38.40	4.83	4.25–5.50
Inside	11.37	1.00	
Indoor play context			
Therapy	20.12	5.58	3.78–8.03
Manipulative	12.91	3.07	2.08–4.52
Sociodramatic	9.74	2.15	1.39–3.32
Transition	27.40	8.00	5.67–11.30
Group time	4.23	1.00	
Outdoor/gym play context			
Ball	45.41	3.02	1.71–5.34
Open space	47.89	3.29	2.59–4.19
Portable	41.54	2.72	1.31–5.64
Wheel	35.34	1.94	1.29–2.90
Fixed	20.95	1.00	
Activity initiator			
Adult initiate	24.70	1.02	0.85–1.22
Child initiate	23.87	1.00	
Group composition/interaction			
Solitary	26.50	3.43	2.87–4.10
1:1 adult, interacting	24.65	2.89	2.47–3.39
1:1 adult, not interacting	15.88	1.69	1.12–2.54
1:1 peer, interacting	17.85	2.02	1.55–2.62
1:1 peer, not interacting	16.46	1.83	1.36–2.46
Group adult, interacting	18.06	1.83	1.53–2.18
Group peer, interacting	24.20	2.64	1.97–3.54
Group peer, not interacting	20.74	2.21	1.76–2.78
Group adult, not interacting	10.02	1.00	

All models controlled for age, sex, diagnosis, and motor skills. A total of 1255 observation intervals were excluded because of missing motor skill information from the VABS-3.
CI, confidence interval; RSB, repetitive/stereotypic behavior.

with group time indoor contexts, physical activity was 8.0, 5.6, 3.1, and 2.2 times more likely to occur when preschoolers with disabilities were in transition, therapy, manipulative play, or sociodramatic play, respectively. When outdoors, preschoolers were significantly more likely to be in TPA when playing in an open space (odds ratio [OR], 3.3), with balls (OR, 3.0), with portable equipment (OR, 2.7), and with wheeled toys (OR, 1.9) compared with fixed equipment play.

With respect to the social environment, after controlling for covariates, there were no differences in TPA between adult-initiated and child-initiated activities. Children with disabilities were 3.4 times more likely to be in TPA when solitary compared with in a group, not interacting. TPA was less likely to be observed when children were not interacting in a group with an adult present compared with any other social setting (Table 4). Logistic regression analyses were not conducted for the physical activity prompt category because of infrequent observations.

DISCUSSION

Children in the present study were primarily sedentary during the preschool day and spent less than 20% of the time in physical activity. The key finding of this study was that certain features of the physical and social environment were significantly associated with physical activity in this sample of children. First, children in this study were more likely to be physically active outdoors compared with indoors. These findings are consistent with studies of typically developing preschool children (23–25). Free play opportunities often occur outdoors and allow for children to freely move about and interact with the environment without being managed by adults. Consequently, children with disabilities accumulate more physical activity in these settings (28,37,38). Sit and colleagues (27) observed that compared with structured play opportunities, the unstructured nature of free play was more conducive to physical activity among school-age children with physical and developmental disabilities. Another study found that classroom management strategies considerably limited the amount of time children with autism spent in physical activity during structured physical education (37). In the present study, certain behavior settings within the outdoor environment were also found to associate with greater levels of physical activity. For example, children in this study were more active in open spaces and while playing with balls or other portable equipment compared with when using fixed playground equipment. These findings were similar to those among typically developing preschoolers (25).

Another important finding of this study was that the preschool day primarily comprised time indoors, and only 12% of that time was spent in physical activity. As with the outdoor environment, the sample of children observed in this study were more active in some indoor contexts than others. Group time is a more structured behavior setting during which the teacher leads the class through preacademic content, and it was the most frequently occurring indoor context for this sample of preschoolers with disabilities. Consistent with a study on typically developing preschoolers, group time was observed to be a very sedentary setting for this sample of children with disabilities (23). Importantly, these children were five times more likely to be physically active in therapy settings compared with group time. Physical, occupational, speech, applied behavior analysis, and music therapy sessions were observed in the present study. Observers reported that sessions were often conducted one-on-one with a therapist or in small groups and were typically held in open spaces such as hallways or empty classrooms. These characteristics of the social and physical environment (i.e., small groups, open spaces) have been found to associate with increased levels of physical activity among typically developing children (23,25,39). Overall, the therapy settings seemed to be the most supportive indoor environments for physical activity in this sample of preschoolers with disabilities.

As with typically developing children, there was evidence that physical activity among this sample of children with disabilities was influenced by the social environment. Participants in this study engaged in similar levels of physical activity during adult- and child-initiated activities. However, physical activity varied by social group composition and whether individuals were interacting within these groups. For example, when the children in this study were interacting one-on-one with a peer or adult, they were more than twice as likely to be in physical activity compared with when they were in a group setting with an adult present, but not interacting. One-on-one support during physical education has been observed to associate with physical activity levels of children with autism (39). Similarly, other studies have concluded that smaller group settings, in general, are more conducive to physical activity (23,25,26,40). It may be that social impairments associated with certain developmental disabilities contribute to lower levels of physical activity when in larger group settings. Memari and colleagues (41), for instance, observed lower levels of physical activity among children with autism who had more significant social impairments compared with those who were less impaired. Furthermore, these social impairments are frequently cited by parents of children with disabilities as a barrier to physical activity participation (42,43).

This study is the first to investigate the associations between the preschool environment and physical activity behaviors among preschoolers with disabilities. Use of the OSRAC-DD was a strength of the study, as it was specifically designed to assess physical activity of young children with disabilities and preschool environmental features. As such, it allowed for the simultaneous recording of unique typologies and contexts, such as stereotypic behaviors and therapy sessions, during which physical activity occurred. Utilizing direct observation also allowed for noninvasive assessment of physical activity and avoided potential difficulties often associated with using devices like pedometers and accelerometers in studies of individuals with disabilities (44). An additional strength was the random allocation of participants and observers to observation sessions, as well as the high levels of interrater reliability.

Lastly, though small, this sample is among the most diverse in studies of preschool-age children with disabilities, as half of the participants were nonwhite and over one-third of the sample comprised girls.

Several limitations of the study should also be considered. The small sample size may have prevented the detection of differences in physical activity by select covariates. Furthermore, MVPA was infrequently observed over the course of the study. As such, we were unable to explore associations between MVPA and preschool environmental contexts. More observation sessions and intervals would be needed to explore these associations. Importantly, physical activity codes from the OSRAC-DD were derived from the CARS (32) but have only been validated for typically developing preschoolers and a small sample ($n = 11$) of children with intellectual disabilities (32,35). Variations in movement patterns and metabolic rates among individuals with disabilities may require greater energy expenditure to perform physical activities (44,45); thus, future studies should further validate the CARS physical activity intensity codes among a larger and more diverse sample of children with disabilities. Lastly, the use of a momentary time-sampling protocol provided an estimate of physical activity among children with disabilities, but it is not a direct measure of physical activity during the preschool day.

CONCLUSIONS

Previous studies have found that the preschool environment significantly influences physical activity of typically developing children during the preschool day. The current study extends those findings to children with developmental disabilities and delays and revealed that characteristics of the physical and social environment were associated with physical activity. Additional research is needed to understand how these characteristics interact and whether environmental modifications can increase physical activity among children with disabilities during the preschool day. Based on the current findings, modifying the environment to improve access to portable play equipment, provide more opportunities for outdoor play, and include opportunities for smaller social group contexts would be a promising first step. Future studies should investigate whether existing preschool physical activity interventions for typically developing children can be modified for preschools that serve children with disabilities. Collectively, these findings and those from past research can inform the development of preschool practices to ensure that all children, including those with disabilities, have access to preschool environments that are supportive of physical activity.

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