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Physical Activity of Preschoolers with Developmental Disabilities and Delays

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PHYSICAL ACTIVITY OF PRESCHOOLERS WITH DEVELOPMENTAL DISABILITIES AND DELAYS

by

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DEDICATION

To the health and wellbeing of all children, especially those who are marginalized. And to all the children with disabilities and their families whom I have had the pleasure of getting to know over the years.

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ABSTRACT

Children with developmental disabilities and delays are at greater risk for developing overweight and obesity compared to typically developing peers. Participation in regular physical activity is a modifiable behavior that is consistently associated with improved weight status and other positive health outcomes. Previous studies have identified numerous individual- and environmental-level factors that associate with physical activity among school-age children with and without disabilities. However, little is known about physical activity behaviors and related correlates among preschool-aged children with disabilities (ages 3 – 5 years), especially while they are in preschool settings. Therefore, the overall purpose of this dissertation was to describe the physical activity behaviors of preschoolers with disabilities and to identify individual- and environmental-level factors that associate with physical activity during the preschool day.

This dissertation was comprised of three studies. In the first study, an observational system for assessing physical activity and related environmental contexts was developed and reliability of the instrument was evaluated. Content validity of the instrument was established through literature reviews, expert consultations, and informal observations in inclusive and special education preschool settings. To determine reliability, paired observers followed a focal child while simultaneously, but independently, recording physical activity and environmental contexts. Reliability sessions occurred during 20% of observation sessions, and interval-by-interval percent agreement and kappa statistics were calculated. The findings of this study indicated that

the new instrument, the Observational System for Recording Physical Activity in Children – Developmental Disabilities (OSRAC-DD), was reliable and suitable for use in inclusive and special education preschool settings.

The second study described the physical activity behaviors of children with disabilities in preschools and identified individual-level factors that associated with physical activity. Mixed linear regression analyses were used to determine the association between objectively measured physical activity and individual-level factors including age, gender, race, diagnosis, level of impairment, motor skill levels, and parent education. All models were adjusted for wear time and preschool was included as a random effect. Results of this study indicated that physical activity was significantly associated with age, race, and diagnosis. Additionally, the preschool setting accounted for nearly half of the variance in physical activity among children with disabilities.

The purpose of the third study was to describe associations between physical activity of children with disabilities and features of the preschool environment. Research assistants were trained to use the OSRAC-DD to directly observe the physical activity behaviors and preschool social and physical environmental characteristics of 34 preschoolers with disabilities. Logistic regression analyses were conducted with observation intervals as the unit of analysis and child nested within school as random effects. All models were adjusted for age, gender, diagnosis, and motor skill level. Findings from this study indicated that the physical activity levels of children with disabilities were associated with features of the physical and social environment within preschool settings. For example, children with disabilities were more likely to be

physically active while outdoors compared to indoors and when in solitary or small group contexts compared to in larger groups with an adult present.

Overall, these three studies describe the physical activity behaviors and related factors among young children with developmental disabilities in preschools. Findings revealed that specific individual- and environmental-level factors significantly associated with physical activity, and that the preschool setting accounted for nearly half of the variability in physical activity. These findings also highlight the importance of preschools as a setting for physical activity promotion of young children with developmental disabilities and the need to create, in preschools, environments that are supportive of physical activity. Collectively, results from the studies included in this dissertation support the application of a multilevel approach to understanding physical activity behaviors of young children with developmental disabilities in preschool settings.

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CHAPTER 1

INTRODUCTION

Beginning in early childhood, individuals with developmental disabilities are at greater risk for developing obesity and other chronic health conditions compared with typically developing children [1–4]. Engaging in regular physical activity is associated with a decreased risk of developing these health conditions and increased cognition and behavioral outcomes [5–8]. To achieve such benefits, young children ages 3 to 5 years should accumulate at least three hours of light, moderate, and vigorous intensity physical activity each day [5]. Physical activity behaviors and related correlates have been widely studied among typically developing children; however, there has been far less research among children with disabilities. Further, there is a paucity of research examining the physical activity behaviors of preschool-aged children with developmental disabilities.

Developmental disabilities, such as Autism Spectrum Disorders, Attention Deficit/Hyperactivity Disorder, Intellectual Disability, and others, affect one in six American children [9]. They are characterized by varying degrees of impairments in physical, learning, language, and behavioral skills [10]. Children with developmental disabilities are often thought to be less physically active compared with typically developing peers [11–16]. However, some studies have observed similar or greater levels of physical activity compared with typically developing peers [17–19]. Such discrepancies can be attributed to measurement methodology as this has varied widely in the literature ranging from self-report to objectively measured physical activity using direct observation or accelerometers [14].

Numerous individual and environmental factors associate with physical activity behaviors of young children with developmental disabilities and can be organized around the socio-ecological model [20, 21]. The socio-ecological model acknowledges that an

individual's behaviors are a function of dynamic interactions between individual-, social-, and environmental-level characteristics. Among children with disabilities, age is the only individual-level factor that consistently associates with physical activity[15, 22, 23]; however, some studies posit that motor and social skill impairments influence overall physical activity [24–27]. Findings of previous studies suggest that certain features of the social and physical environment across settings are also important predictors of physical activity in children with developmental disabilities [11, 28, 29], but these studies have been limited to older children (>6 years).

To date, few studies have investigated the physical activity patterns of preschoolers with developmental disabilities, and, to our knowledge, no study has explored these patterns during the preschool day. Approximately 36% of preschoolers with developmental disabilities are enrolled in a childcare center and spend a considerable amount of time in care each week [30]. Therefore, childcare centers and preschools are important settings for the study and promotion of health-promoting physical activity behaviors in this population. To address this gap in the literature, the purpose of this dissertation was twofold: 1) to describe the physical activity levels of preschoolers with developmental disabilities and 2) to identify child and social and physical environmental factors associated with physical activity. Three cross-sectional, observational studies were conducted to address these aims. Convenience samples of young children with developmental disabilities were recruited from childcares and preschoolers throughout South Carolina and physical activity was objectively measured using accelerometers and direct observation. These studies were supported by grants from

the University of South Carolina Office of the Vice President for Research and the Healthy Weight Research Network.

An initial study was designed to develop an observational instrument to be used for the investigation of physical activity patterns of children with developmental disabilities. Existing preschool physical activity observation instruments were reviewed, and content validity was established through literature reviews, field observations, and discussions with special education teachers, directors, and therapists. The resulting instrument allows for the simultaneous recording of physical and social contextual circumstances during inclusive and special education preschool settings. A convenience sample of children with developmental disabilities were recruited from ten classrooms. Inter-observer agreement was established between two trained observers and the instrument was deemed to be reliable for assessing physical activity behaviors among this population.

A second study investigated physical activity among preschoolers with developmental disabilities during the preschool day and the child-level factors that associated with physical activity. Preschoolers with disabilities are vastly understudied and it is unclear how the preschool environment contributes to daily physical activity levels. Further, empirical evidence about the associations between physical activity and age, race, diagnosis, level of impairment, and socioeconomic status is lacking. To achieve the aims of this study, a cross-sectional study design was employed, and a convenience sample of preschoolers was recruited from inclusive and special education childcares and preschools. Physical activity was measured by accelerometry and child-level factors were determined through parent surveys and semi-structured interviews.

Lastly, a third study explored the influence of social and physical environmental characteristics of preschool settings on the physical activity behaviors of children with developmental disabilities. Physical activity and preschool environmental variables were assessed using the instrument designed in study one. The percentage of time spent in physical activity across social and physical environmental contexts was assessed, and the likelihood of a child being physically active in certain preschool behavior settings, was calculated.

Previous studies have identified patterns and predictors of physical activity among children and adolescents with developmental disabilities, but preschoolers with disabilities have often been excluded. Overall, the three studies presented in this dissertation contribute to the literature by identifying patterns of physical activity among children with disabilities during the preschool day and by identifying individual- and environmental-level factors that associate with physical activity. These findings extend the physical activity literature to a younger sample of children with disabilities. Further, results of these studies highlight the importance of exploring preschools as a setting for physical activity promotion of young children with disabilities and can inform potential intervention strategies.

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CHAPTER 2

AN OBSERVATION SYSTEM TO ASSESS PHYSICAL ACTIVITY OF CHILDREN WITH DEVELOPMENTAL DISABILITIES AND DELAYS IN PRESCHOOL

Abstract

Objectives: To establish content validity and reliability of an instrument for measuring physical activity (PA) of preschoolers with developmental disabilities (DD), and to identify preschool social and physical environmental factors that associate with PA.

Design**:** Inter-rater reliability was determined in a convenience sample of children using a cross-sectional design.

Methods: Content validity was established through consultation with experts, informal observations in inclusive and special education preschools, and literature reviews. Relevant categories and codes were identified and modified from existing observational systems for young children. Data were collected using a momentary time sampling system (5-sec observe, 25-sec record) following a focal child, and reliability was assessed during 20% of the observation sessions.

Results: The instrument development process resulted in ten coding categories that accounted for PA levels, types, and social and physical environmental contexts relevant to this population (e.g., therapy and related services, stereotypic behaviors, social interaction). Observers completed 137.5 observation sessions, yielding 5,498 30-second observation intervals. Interval-by-interval percent agreement was excellent (91%-100%) and kappa values were high (0.82 – 0.99).

Conclusions: The instrument was found to be a reliable measure of PA of preschoolers with DD and to provide important contextual information about PA behaviors in early childhood special education settings. Additionally, it allows for the simultaneous measurement of specific types and contexts of PA behaviors of preschoolers with DD and will be useful for describing PA and informing future interventions.

Introduction

Physical activity promotion among young children is a significant public health priority that aims to curb childhood obesity and prevent the development of other chronic diseases later in life [1]. It is recommended that preschool-aged children (ages 3 – 5 years) accumulate at least three hours of total physical activity (light, moderate, and vigorous) per day, and approximately half of preschoolers do not meet these guidelines [1, 2]. Similarly, most children with developmental disabilities fail to meet physical activity guidelines [3–8]. Developmental disabilities are characterized by impairments in several domains including, but not limited to, self-care, receptive and expressive language, mobility, self-direction, and learning [9]. Studies specific to physical activity in preschool-aged children with disabilities are sparse, as most prioritize youth and adolescents, and offer limited insight into the contextual circumstances surrounding physical activity [10–15].

Direct observation has been widely used to assess typically developing children's physical activity and related contextual circumstances and is considered a gold standard [16]. However, few instruments have been used among preschool-aged children with developmental disabilities. The Behaviors of Eating and Activity for Children's Health Evaluation Survey (BEACHES) was used to investigate contextual factors at home and school that influence physical activity of children (n = 35; mean age = 15.7 ± 4.3 years; 28.6% = ages 4 – 6 years) with physical disabilities [17, 18] and was validated in a small sample of children (n = 5; ages 6-12 years) with cerebral palsy [19]. The Children's Activity Rating Scale (CARS) records children's physical activity on a scale of 1 to 5 and has been validated among preschoolers and a small sample of children with intellectual

disabilities [20, 21]. These physical activity codes are also used in the Observational System for Recording Activity in Children – Preschool version, a momentary time sampling system that allows for simultaneous recording of physical activity and features of the physical and social environment [22]. The OSRAC-P has been used to evaluate the influence of the social environment on physical activity behaviors of preschool-aged children with autism during inclusive summer camp [23]. Children with autism were significantly less physically active in social group settings compared with solitary settings during free play, however the degree to which the children were interacting within social groups is unknown [23]. Both instruments offer insights into contextual circumstances surrounding physical activity, but they were designed for use with typically developing children. Therefore, they lack contextual factors unique to children with developmental disabilities. There is a need for an observation instrument that addresses these factors and can be used in settings common for young children with disabilities

Most young children, including those with developmental disabilities, spend a large portion of the day in structured childcare program [24, 25]. As such, childcare and preschool settings pose a unique opportunity to investigate physical activity behaviors of young children with developmental disabilities and related physical and social environmental contexts. To our knowledge, there is no direct observation instrument that sufficiently captures physical activity behaviors and contextual factors of inclusive and special education preschool environments. Therefore, the purpose of this paper is to develop an instrument for direct observation of physical activity and related contextual factors in preschool children with developmental disabilities.

Methods

This study was conducted in two distinct phases: 1) instrument development, and 2) instrument evaluation.

Phase 1: Instrument development. Two existing observation instruments have been used to measure physical activity and corresponding environmental contexts of children with disabilities [17, 22] and were reviewed for utility in the inclusive and special education preschool settings. Both instruments used a similar coding scheme for recording physical activity intensity, but each captured different levels of detail within social and physical environments. For example, social environment in the OSRAC-P was first defined by interaction (i.e., interaction between the focal child and one or more individuals) and then proximity (i.e., if interaction is unclear) whereas BEACHES accounted for both proximity (i.e., individuals within three feet of focal child) and interaction (physical or verbal). Overall, the OSRAC-P provided the most detailed account of behavioral settings in which physical activity occurs during preschool and was selected to serve as the foundation of the new instrument, which we will refer to as the Observational System for Recording Activity in Children – Developmental Disabilities version (OSRAC-DD).

Content validity for the OSRAC-DD was established through visits to 10 preschool classrooms, discussions with preschool directors, teachers and therapists, and literature reviews. Preschool teachers and directors provided researchers with typical classroom schedules and discussed the various child behaviors and important preschool contexts that occur during the day. During field observations, researchers recorded observed child-level behaviors (e.g., stimming, hand flapping, body rocking), preschool

behavioral settings (e.g., therapy sessions, sensory rooms), and social circumstances (e.g., one-on-one sessions with therapists, interactions with clinical students and volunteers) unique to inclusive and special education classrooms. Based on the observations, the decision was made to retain the original eight coding categories of the OSRAC-P: 1) Physical Activity Level, 2) Physical Activity Type, 3) Location, 4) Indoor Activity Context, 5) Outdoor Activity Context, 6) Activity Initiator, 7) Group Composition, and 8) Prompts. The observations and literature reviews also informed modifications to existing definitions, development of new categories, and creation of relevant codes. Specifically, additional codes were added to account for therapy sessions as a behavioral context and the presence of therapists in the social environment. Additionally, a category was created to record repetitive/stereotypic behaviors. Lastly, to enhance specificity of the social environment, interaction and engagement categories were developed based in the Individual Child Engagement Record – Revised version (ICER-R), a valid and reliable observation instrument used in inclusive and special education school settings [26].

The preliminary version of the OSRAC-DD was comprised of 11 categories, including three categories specific to the new instrument: 1) Repetitive Behavior/Stereotypy, 2) Engagement, and 3) Interaction. As with other OSRAC instruments, the OSRAC-DD employed momentary time-sampling procedures to observe a focal child for 20-minute observation sessions. These sessions were comprised of 30-second coding intervals (5-second observe, 25-second record intervals) and were repeated continuously during 20-minute observation sessions. A research assistant with prior experience working with preschoolers with disabilities was trained to utilize the OSRAC-DD. Research assistant training consisted of: 1) orientation sessions to introduce the

instrument and methodology, 2) reviewing the training manual, protocols, and codes, 3) memorizing operational definitions, 4) completing written assessments, 5) coding videos of preschoolers with disabilities in preschool settings, 5) reviewing and discussing codes and protocol, 6) informally observing inclusive special education preschools, 7) conducting *in situ* observations in pairs and debriefing, and 8) conducting independent observations in an inclusive and special education classroom. Independent observation sessions were repeated until the research assistant achieved at least 80% agreement in all OSRAC-DD coding categories [22]. Following observer training, reliability of the OSRAC-DD was established through field testing in inclusive and special education classrooms.

Phase 2: Instrument Evaluation. A cross-sectional pilot study was conducted to evaluate the instrument's reliability and was approved by the University of South Carolina's Institutional Review Board. A convenience sample of 25 preschool-aged children with developmental disabilities and delays were recruited from an early childhood center and a special education daycare setting. Most participants (80%) were enrolled in a special education classroom whereas the remaining students were in an inclusive classroom environment. Six children were excluded from the study because they had not yet been formally diagnosed with developmental disability or delays, or they had a medical concern that could impair independent movement. Therefore, 19 children were eligible for the study (see Table 2.1).

Parents and guardians provided consent prior to the study and were asked to complete a brief parent survey. The survey queried parents on the age, gender, and diagnosis of the participating child. Parents also reported on the source of their child's

diagnosis (e.g., pediatrician, psychologist, specialist), past and current special education services, and current therapy services based on items from the National Survey of Children's Health [27]. Participants (mean age = 4.76 ± 0.7 years; 57.0% white) were primarily male (68.4%) and most were diagnosed with autism (78.9%). At the time of the study, 47.4% of parents reported that their child was receiving early intervention services through an Individualized Family Service Plan and 61.1% of children received these services before age 3. All kids were receiving at least one form of therapy including speech therapy (89.5%), occupational therapy (68.4%), physical therapy (36.8%), or other therapies such as cognitive therapy and applied behavioral analysis (52.6%). After completing the survey, parents received a modest stipend to thank them for their time and effort.

Trained research assistants observed participating children using a focal child, momentary time-sampling protocol consisting of 30-second observation intervals (5-second observe, 25-second record). Observation sessions were 20-minutes in duration and yielded 40 observation intervals per session. Daily schedules were obtained from preschool teachers and children were randomly allocated to observation time slots, excluding planned nap and mealtimes. Then research assistants were randomly assigned to observation sessions. Data were entered into tablet computers which were equipped with the Multi-Option Observation System for Experimental Studies (MOOSES) program and corresponding LILY data collection software [28]. OSRAC-DD categories and codes were organized in columns on a single screen and a timed audio prompt indicated when the observer should observe and record the data. OSRAC-DD categories are mutually exclusive and during each interval, observers independently recorded the

highest estimate of physical activity intensity followed by the corresponding physical activity type and social and physical environmental contexts. Inter-rater reliability assessment was planned for at least 20% of the observation sessions. Pairs of research assistants simultaneously, but independently, observed the same focal child during these sessions using split headphones and auditory prompts.

Physical activity levels were aggregated to provide estimates of sedentary (levels 1 and 2 combined), light (level 3) and moderate-to-vigorous (levels 4 and 5 combined; MVPA) physical activity. The overall percentage of intervals spent in sedentary, light, and MVPA were calculated. The percentage of intervals spent in physical activity by location (indoor, outdoor, transition), type, stereotypic behavior, and environmental context variables (e.g., indoor contexts, outdoor contexts, social group) were also calculated.

Percent agreement for each category was calculated for inter-rater reliability sessions using the following equation: [#agreements/(#agreements+#disagreements)] x 100. Cohen's kappa was calculated for all inter-rater reliability assessments (20% of observation sessions). Session-level percent agreements and kappa values were averaged to provide overall mean percent agreement and kappa values and are presented in Table 2.2.

Results

There were 136 observation sessions which yielded 5,498 30-second observation intervals. Preschoolers with disabilities spent 77.7% of the time in sedentary behavior and engaged in MVPA 4.0% of the time during preschool hours (Table 2.3). The most frequently observed types of physical activities were sitting/squatting (51.6%) and

standing (20.2%), followed by walking (16.7%). Preschoolers spent 85.8% of the time in an indoor education or play context and most of this time was sedentary (84.2%). The most frequently occurring indoor play and educational contexts were group time (19.3%), transition (12.3%), and therapy (10.3%), all of which were mostly sedentary. When in the outdoor or gym environments (10% of the time), children engaged in primarily sedentary (42.5%) or light (41.0%) activities. The most frequently occurring outdoor or gym contexts were open space (8.8%), fixed equipment (3.5%), and ball play (1.3%). Adults initiated activities 49.8% of the time and preschoolers spent most of the time in a group setting with an adult (41.9%) or among a group of peers (16.4%). Within the social group settings, there were no observed interactions during 60.1% of the observation intervals. Prompts to increase physical activity occurred less than 1% of the time.

Inter-observer reliability was assessed during 28 observation sessions (20.6% of sessions), yielding 1,120 observation intervals. There was a high level of percent agreement between observers for all OSRAC-DD observation categories (range = 91% - 100%). Lower scores were observed among Interaction (kappa = 0.82, % agreement = 92.0%), Initiator (kappa = 0.85, % agreement = 94.0%), and Physical Activity Level (kappa = 0.87, % agreement = 91.0%). Physical activity level had the lowest percent agreement largely due to the difficulties in distinguishing between Level 1 (stationary and motionless) and Level 2 (stationary with movement of limbs or trunk) movements. Kappa coefficients were calculated to account for the possibility that observers agreed by chance and mean kappa and standard deviations for each category are presented in Table 2.2. Kappa coefficients ranged from 0.82 to 0.99 indicating great levels of interrater reliability across all categories.

The final version of the OSRAC-DD consisted of ten coding categories: 1) Physical Activity Level, 2) Physical Activity Type, 3) Repetitive/Stereotypic Behaviors, 4) Location, 5) Indoor Activity Context, 6) Outdoor/Gym Activity Context, 7) Activity Initiator, 8) Group Composition, 9) Interaction, and 10) Prompts. The Engagement category was excluded from the final instrument due to difficulty in discerning true engagement during physical activity settings (e.g., outdoors during recess, free play in a gym) and the "physical prompt" code was moved from the Engagement to the Interaction category.

Discussion

The primary finding of this study was that the OSRAC-DD is a reliable instrument for assessing the physical activity behaviors and preschool contexts among children with developmental disabilities. There was high inter-rater reliability among all OSRAC-DD coding categories. These results are comparable to those of other direct observation instruments for preschoolers [17, 22]. Brown et al. similarly reported high levels of agreement for all OSRAC-P categories with lower levels observed in the Group Composition, Physical Activity Level, and Initiator categories [22]. In both studies, disagreements between observers in the Physical Activity Level category often occurred between levels 1 (stationary) and 2 (stationary with limb movement), however this was not concerning as these levels are aggregated to determine overall sedentary behavior. As was the case in the Brown et al. study, disagreements in the Initiator category were often the result of missed contextual indicators of the activity initiator and the same code was recorded across multiple observation intervals [22]. Lastly, levels of agreement in the

Interaction category were higher than reported in other studies (kappa = 0.73-0.79) [29, 30].

Consistent with other studies of children with and without disabilities, participants were primarily sedentary during the school day [19, 22, 31]. While both the OSRAC-P and BEACHES provide rich contextual information about physical activity and environmental contexts, neither instrument allows for the recording of additional contexts that are relevant to children with disabilities (e.g., repetitive/stereotypic behaviors, therapy, interactions with therapists). Extensive efforts were taken to identify these important contexts and establish content validity through several literature reviews, discussions with special education preschool directors and therapists, and classroom observations. As such, the OSRAC-DD has considerable advantages over other instruments to assess physical activity among preschoolers with disabilities. Some researchers have hypothesized that the repetitive and stereotypic behaviors often demonstrated by young children with disabilities may contribute to overall physical activity levels [32–34] but this has yet to be investigated. Linking the OSRAC-DD physical activity intensity data with that of stereotypic behavior occurrences may help to explore these questions. Additionally, evidence suggests that the social environment may influence physical activity levels in certain settings [23] and the addition of the Interaction category in the OSRAC-DD will allow for this relationship to be further investigated.

There are several strengths and limitations of the present study. The categories and codes contained in the OSRAC-DD allow for rich, descriptive recording of physical activity behaviors and the contexts during which they occur in inclusive and special

education settings. Codes are specific to preschool settings and include relevant contexts for children with developmental disabilities (e.g., repetitive behavior/stereotypy, therapy contexts, interaction with peers or adults). Next, the broad categories and codes within the OSRAC-DD are appropriate for use in both special education and inclusive preschool classrooms, which allows for simultaneous study of physical activity of children with and without disabilities. However, limitations of the instrument should be considered. First, although the physical activity codes used in the OSRAC-DD have been validated for typically developing children [20], they have only been validated among a small sample of children with intellectual disabilities ($n = 11$; $r = 0.61$) [21]. Most participants in our sample had an autism diagnosis and children with other disabilities were largely underrepresented. Future studies should replicate this study and validate physical activity codes among a larger and more diverse sample of children with disabilities. Another limitation of the OSRAC-DD is that, due to the nature of the 5-second observe, 25-second record observation intervals, it provides an estimate and not a direct measure of time spent in physical activity. Lastly, as with many direct observation systems, the OSRAC-DD is very time- and resource-intensive. In order to establish high levels of reliability, observers spent a considerable amount of time studying the OSRAC-DD manual and conducting field observations in inclusive and special education classrooms.

Conclusion

The OSRAC-DD is a reliable observational instrument which contextualizes physical activity behaviors of preschoolers with developmental disabilities. This instrument allows for unique insights into the physical activity behaviors of preschoolers with developmental disabilities and can be used in comparative studies between children with

and without disabilities. Further, it has the potential to be used for intervention evaluation as well as observational studies that aim to identify social and physical environmental correlates of physical activity among populations with disabilities. Identifying these correlates can aid in the development of more inclusive physical activity opportunities for children with developmental disabilities, resulting in health and developmental benefits as they age.

Table 2.1. Demographic characteristics of participating children.

n	19
Gender male, n (%)	13 (68.4)
Age, years (SD)	4.76 (0.7)
Race/Ethnicity, n (%)	
White	11 (57.9)
Black/African American	4 (21.1)
Hispanic/Latino, White	2 (10.5)
Other or more than one race	2 (10.5)
Diagnosis	
Autism	15 (78.9)
Developmental Delay	2 (10.5)
Down Syndrome	2 (10.5)
Diagnosis made by:	
Pediatrician	11 (57.9)
Specialist	5 (26.3)
School Psychologist/Counselor	5 (26.3)
Psychologist	3 (15.8)
Other	8 (42.1)
Classroom Type	
Inclusive	4 (21.5)
Special Education	15 (78.9)
Received Early Intervention Services before age 3yrs	11 (61.1)
Currently Receive Early Intervention Services	9 (47.4)
Receive Special Education Services	12 (63.2)
Currently Receiving Therapy:	
Physical Therapy	7 (36.8)
Speech Therapy	17 (89.5)
Occupational Therapy	13 (68.4)
Other Therapy	10 (52.6)

Table 2.2. Average kappa coefficients and interobserver percent agreement by OSRAC-DD coding category.

		Mean	SD
Physical Activity Level	Kappa	0.87	0.11
	Percent Agreement	0.91	0.08
Physical Activity Type	Kappa	0.96	0.04
	Percent Agreement	0.96	0.04
Stereotypic/Maladaptive Behavior	Kappa	0.97	0.06
	Percent Agreement	0.97	0.06
Location	Kappa	0.95	0.17
	Percent Agreement	0.99	0.03
Indoor Activity Context	Kappa	0.94	0.10
	Percent Agreement	0.94	0.10
Outdoor Activity Context	Kappa	0.99	0.04
	Percent Agreement	0.99	0.04
Activity Initiator	Kappa	0.85	0.29
	Percent Agreement	0.94	0.12
Group Composition	Kappa	0.92	0.07
	Percent Agreement	0.92	0.06
Interaction	Kappa	0.82	0.16
	Percent Agreement	0.92	0.08
Engagement	Kappa	0.89	0.08
	Percent Agreement	0.93	0.06
Prompts	Kappa	0.96	0.19
	Percent Agreement	1.00	0.01
Reactivity	Kappa	0.99	0.04
	Percent Agreement	0.99	0.04

Table 2.3. Observed OSRAC-DD codes and percentages of intervals by activity level.

		Percentage of Intervals		
Categories, Observed Codes	Observed Intervals	Sedentary	Light	MVPA
Total Observed Intervals	5393	77.7	18.2	4.0
Location				
Inside	4617	84.2	13.3	2.5
Outside	546	42.5	41.0	16.5
Transition	230	30.9	63.9	5.2
Physical Activity Type				
Sit/Squat	2880	99.9	0.1	0.0
Stand	1132	99.5	0.5	0.0
Walk	934	0.5	94.2	5.2
Lie Down	122	100.0	0.0	0.0
Run	113	0.0	0.0	100.0
Jump/Skip	72	1.4	36.1	62.5
Ride	31	6.5	67.7	25.8
Climb	21	4.8	95.2	0.0
Crawl	21	33.3	66.7	0.0
Pull/Push	17	35.3	11.8	52.9
Throw	17	76.5	17.6	5.9
Swing	14	100.0	0.0	0.0
Dance	11	36.4	63.6	0.0
Rock	7	100.0	0.0	0.0
Other	7	100.0	0.0	0.0
Rough and Tumble	2	0.0	0.0	100.0
Roll	1	0.0	100.0	0.0
Repetitive/Stereotypic Behavior				
None	5205	77.9	18.4	3.7
Object	73	84.9	12.3	2.7
Motor	66	48.5	16.7	34.8
Vocal	46	82.6	17.4	0.0
Indoor Education/Play Contexts				
Group Time	1036	95.2	3.5	1.4
Transition	662	60.6	37.3	2.1
Therapy	556	90.8	9.0	0.2
Manipulative	496	84.7	11.3	4.0
Books/preacademic	464	90.1	9.7	0.2
Videos	323	98.5	1.5	0.0
Snacks	299	98.3	1.7	0.0
Art	154	92.9	6.5	0.6
Sociodramatic	108	88.0	10.2	1.9

Self Care	86	74.4	24.4	1.2
Time Out	47	100.0	0.0	0.0
Large Blocks	26	46.2	42.3	11.5
Other	17	88.2	11.8	0.0
Teacher Arranged	10	100.0	0.0	0.0
Music	8	75.0	25.0	0.0
Gross Motor	6	100.0	0.0	0.0
Outdoor/Gym Education/Play Contexts				
Open Space	475	34.5	42.7	22.7
Fixed	191	53.4	35.1	11.5
Ball	69	44.9	37.7	17.4
Portable	51	58.8	41.2	0.0
Wheel	41	26.8	53.7	19.5
Sandbox	29	86.2	13.8	0.0
Time Out	18	94.4	5.6	0.0
Socioprops	3	100.0	0.0	0.0
Snacks	1	100.0	0.0	0.0
Activity Initiator				
Adult Initiated	2735	85.3	13.2	1.5
Child Initiated	2056	66.1	25.8	8.1
Therapist Initiated	574	85.2	14.6	0.2
Peer Initiated	28	39.3	32.1	28.6
Group Composition				
Group Adult	2348	82.6	14.9	2.5
Group Peer	908	71.9	20.8	7.3
Solitary	715	70.5	22.7	6.9
1-1 Adult	577	74.4	22.5	3.1
1-1 Peer	557	76.7	18.7	4.7
1-1 Therapist	288	82.6	17.0	0.3
Interaction				
No Interaction	3337	79.2	17.3	3.5
Interaction with Adult	712	73.6	24.0	2.4
Interaction with Group	545	76.1	16.1	7.7
Interaction with Peer	486	72.8	18.7	8.4
Interaction with Therapist	312	81.4	17.9	0.6
Engagement				
Active Engagement	3301	69.4	24.8	5.8
Passive Engagement	1194	97.9	1.9	0.2
Passive Non-Engagement	361	98.6	1.4	0.0
Active Non-Engagement	340	72.6	22.1	5.3
Physical Prompt				
Prompts				
No Prompt	5354	77.9	18.2	3.9

Teacher Prompt - Increase	21	66.7	14.3	19.0
Teacher - Prompt Decrease	10	50.0	20.0	30.0
Therapist Prompt - Increase	6	33.3	66.7	0.0
Peer Prompt - Increase	1	0.0	0.0	100.0

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CHAPTER 3

PHYSICAL ACTIVITY BEHAVIORS OF PRESCHOOLERS WITH DEVELOPMENTAL DISABILITIES AND DELAYS

Abstract

Little is known about the patterns of and factors that associate with physical activity (PA) among preschoolers with disabilities. The purpose of this study was: 1) to describe the PA behaviors of young children with disabilities in preschool settings, and 2) to examine associations between child level factors and PA during the preschool day. Preschoolers with autism (n=16) and other disabilities (n=18) wore an accelerometer during preschool and were evaluated on adaptive behavior skills. Preschool settings accounted for 49% of the variance in PA. Age, race, and diagnosis significantly associated with PA, but there were no associations by gender, level of impairment, or motor skills. Future studies should further explore preschool characteristics and disability-specific factors to identify potential intervention strategies.

Introduction

Developmental disabilities such as Down syndrome, Cerebral Palsy, Autism Spectrum Disorders, and Intellectual Disability, affect approximately one in six children in the United States [1]. These conditions involve substantial impairments in self-care, receptive and expressive language, mobility, self-direction, and learning [2]. Even in early childhood, those with developmental disabilities are at greater risk for chronic health conditions, such as obesity, that may persist into adulthood [3–5]. Regular participation in physical activity can reduce the risk of developing these health conditions and improve cognition, social skills, and maladaptive behaviors [6–10]. It is recommended that preschool-aged children (ages 3 – 5 years) accumulate approximately 3 hours of daily physical activity [10]; however, many children do not meet this recommendation [11, 12].

Young children spend nearly 23 hours per week in nonparental childcare arrangements, and over a third of 3- to 5-year old children with disabilities are enrolled these settings [13]. Preschool settings afford numerous opportunities for structured and unstructured play which contribute to children's daily physical activity. Empirical studies have found that the preschool a child attends accounts for up to 46% of the variance in physical activity which may be attributed to features of the social and physical environment [13, 14]. However, there is a paucity of research investigating the role of the preschool setting on physical activity of young children with disabilities.

Previous studies have demonstrated that child level factors such as age, gender, and weight status associate with young children's physical activity in and outside of the preschool setting [15–21]. These factors have seldom been explored among preschoolers

with disabilities. Similar to typically developing children, children with disabilities experience an age-related decline in physical activity [22–24]; however, observations of the association between gender and physical activity have yielded inconsistent findings [25]. Memari et al. found that adolescent girls with autism were less active than boys, but another study observed no differences by gender [23, 26]. Characteristics of specific disabilities and level of impairment may also be associated with physical activity. Among children with autism, as symptom severity increased, they were less likely to participate in physical activity [26]. Further, children with greater social impairments were significantly less active compared with those who were less socially impaired [27].

Overall, little is known about the associations between demographic and disability-specific factors that may associate with physical activity among children with developmental disabilities. Further, few studies have included preschool-aged children [25, 26, 28–30], and no study has investigated physical activity of children with disabilities while in the preschool setting. Therefore, the purposes of this study were to describe the physical activity levels of children with developmental disabilities in preschool settings and to examine associations between selected child level factors and physical activity during the preschool day.

Methods

Setting and Participants

A convenience sample of children was recruited (n = 34; M_{age} = 4.28 ± 1.07 years) from inclusive and special education preschools (n = 5) in a southeastern state. In this paper, "inclusive" refers to settings which include both typically developing children and children with disabilities or developmental delays. Parents and caregivers provided

consent for their child to participate in this cross-sectional study. Inclusion criteria were: 1) child was enrolled in an inclusive or special education preschool classroom, 2) child had a diagnosed disability or developmental delay from a health care provider or other professional, and 3) child was ambulatory and without medical conditions that could impact mobility. Most children had multiple diagnoses but were grouped under one of two primary diagnoses: autism or developmental delay. Speech delay was the most frequently occurring co-diagnosis (n=32, 94.12%). This study was approved by the University of South Carolina's Institutional Review Board and families received a modest incentive for participating.

Measures

Demographic Survey

A brief survey was administered to assess basic demographic variables including birthdate, sex, diagnosis, ethnicity, and race. Parents reported the type of health provider or professional who diagnosed their child, the age at which their child began receiving special education services, current therapy services, and their perceptions of their child's daily living and social skills relative to typically developing children. Survey items were adapted from the National Survey of Children with Special Health Care Needs [31]. Parents also reported their level of education which served as a proxy for socioeconomic status.

Vineland Adaptive Behavior Scale – 3

Adaptive behavior skills were assessed using the Vineland Adaptive Behavior Scale – 3 (VABS-3) Comprehensive Parent Interview [32]. This instrument provides a norm-based assessment that is used in clinical practice to classify functioning of children

and adults (ages 0 – 90 years) with developmental disabilities. Individuals are evaluated on three core domains, communication, socialization, and daily living skills, and two optional domains, motor skills and maladaptive behaviors. During semi-structured interviews, parents or caregivers responded to a series of domain-specific questions and the administrator recorded responses as "2" (often demonstrates skill), "1" (sometimes demonstrates skill), or "0" (never demonstrates skill). The interview continued until a "basal" and "ceiling" were established. Following the interview, the items were scored in Q-Global™, an online, secure platform, and an Adaptive Behavior Composite (ABC) core was calculated based on responses to the three core domains. ABC scores are often used for diagnostic or eligibility decisions [32], but in the present study they were used to determine the degree of impairment for each participant.

Accelerometry

Physical activity was measured using ActiGraph GT3X accelerometers (Pensacola, FL). These devices are widely used to assess physical activity of typically developing children and have been frequently used in populations with developmental disabilities [30]. Accelerometers were fastened to an elastic belt and worn around the waist over the right hip, consistent with the literature. Due to the sporadic nature of young children's physical activity, accelerometers were initialized to collect data in 15 second epochs. Accelerometer data were processed using ActiLife software. Validated cut-points for preschoolers with developmental disabilities have not yet been established, however consistent with another study of this population, Pate et al. cut-points were applied to determine sedentary (<799 counts/min) light (800-1679 counts/min), moderate-to-vigorous (≥1680 counts/min) and total (≥800 counts/min) physical activity

[33, 34]. Accelerometer start and stop points for each child and day were applied and periods of non-wear time were defined as 60-minutes of consecutive zeros and were excluded from the analyses. Participants who wore the monitor for at least 50% of the school day for three or more days were included in the analyses [35].

Procedures

After consenting to participation in the study, parents completed the demographic survey and were scheduled to complete the VABS-3. Interviews were conducted by a trained investigator over the phone and were administered using the online Q-Global™ platform. A pre-determined script about the VABS-3 was recited to parents, emphasizing that there were no "right" or "wrong" answers, and parents were provided with an opportunity to ask questions before the interview began. The starting point for each interview was based on the child's chronological age and the average time to complete the VABS-3 assessment was 68 minutes. Multiple attempts were made to reach families to complete the interview, but four families did not complete the procedure.

Physical activity data were collected during five consecutive days at each preschool location. At the beginning of each day, research assistants attached accelerometers around the waists of participating children and recorded start times in an accelerometer log. Teachers were asked to make note if children removed the accelerometer before the end of the school day. Accelerometers were removed by preschool teachers or the research staff at the end of the day, and stop times were recorded in the accelerometer log.

Analyses

Descriptive statistics were used to summarize demographic characteristics of study participants. Then, one-way ANOVA models were used to test for univariate associations between physical activity and child-level characteristics including gender, race, diagnosis, level of impairment, level of motor skills, and parent education subgroups. Race and ethnicity were categorized as "white" and non-white". VABS-3 qualitative descriptors were applied to overall ABC and motor skill domain scores to create categories for impairment and motor skill levels, respectively. Children with scores of 70 and below were classified as "more impaired", and children with scores of greater than 70 were classified as "less impaired" [32].

Mixed linear regression models were created to examine independent associations between physical activity and child-level variables. In these analyses, preschool was included as a random effect to control for potential correlations among children in the same preschool class. Separate models were run for each dependent variable (minutes per hour in moderate-to-vigorous physical activity and total physical activity) and were adjusted for accelerometer wear time. The first model included age, gender, and race as independent variables. Additional variables (diagnosis, level of impairment, motor skills, parent education) were iteratively added to subsequent models. Significance was set as $a = 0.05$. All analyses were conducted in SAS Studio 3.71 Release (SAS Institute, Inc., Cary, NC).

Results

Participant demographic characteristics and overall levels of physical activity are summarized in Table 3.1. There were no significant differences in age, gender,

race/ethnicity, parent education, adaptive behavior skills, or motor skills between children with autism and those with developmental delay ($p = 0.24 – 0.75$). Overall, participating children spent 74.7% of the time sedentary, and 25.3% of the time in light, moderate, or vigorous physical activity. Those with autism spent a greater percentage of time in physical activity and less time in sedentary behavior compared with those with developmental delays (see Table 3.1).

Univariate associations between child-level characteristics and physical activity variables were examined for the whole sample and are summarized in Table 3.2. There were significant associations between the preschool attended and time spent in sedentary behavior and moderate-to-vigorous, and total physical activity ($p<0.01$). The preschool a child attended accounted for 43.7% and 49.8% of the variance in total and moderate-to-vigorous physical activity, respectively. Primary diagnosis was significantly associated with sedentary, light, moderate-to-vigorous, and total physical activity ($p < 0.05$). Parent education level was significantly associated with light physical activity ($p = 0.03$). Gender, race, level of impairment, and motor skill group were not associated with any of the physical activity level variables.

Multivariate models were used to examine independent associations between the child-level variables and physical activity. Analyses were controlled for preschool and accelerometer wear time. In the adjusted models, age, race, and primary diagnosis were significantly associated with moderate-to-vigorous physical activity (see Table 3.3). Non-white children were significantly more active than white participants ($p< 0.01$), and children with autism were significantly more active than children with developmental delay ($p = 0.01$-0.04). Gender, level of impairment, and motor skill level were not

significantly associated with moderate-to-vigorous physical activity in the adjusted models. For total physical activity, age and race were significantly associated with physical activity in models 1 through 4. After accounting for level of impairment, motor skill level, and parent education, only race remained significant in model 5 (see Table 3.3). Gender, diagnosis, overall level of impairment, and motor skill level were not associated with total physical activity after adjusting for accelerometer wear time and school.

Discussion

The major finding of this study was that nearly half of the variance in physical activity among children with disabilities was explained by which preschool a child attended. This suggests that, as with typically developing children, the preschool setting is an important predictor of physical activity for children with disabilities. Some features of the preschool environment may be more conducive to physical activity than others. For example, previous studies have observed that physical activity increases with greater access to portable play equipment, more open space, and time outdoors [36–41]. Other studies have reported greater levels of physical activity among schools that provide ample physical activity opportunities and teacher training [36, 42]. These preschool characteristics have not yet been explored in inclusive or special education preschools, but it is reasonable to suspect that they will also considerably influence the physical activity of children with disabilities.

Next, certain demographic factors emerged as important predictors of physical activity. After controlling for school and wear time, age was consistently and positively associated with physical activity in nearly all models. Previous studies of school-aged

youth have demonstrated a negative association between age and physical activity, but these studies did not include preschool-aged children [23, 25]. It may be that the preschool years are highly active for children with disabilities, but at some point, the relationship between age and physical activity shifts resulting in a decline in activity. Longitudinal studies are warranted in order to investigate the patterns of physical activity from early childhood to adolescence and identify the point at which activity begins to decline. Another factor that was associated with physical activity was race and ethnicity. White children were significantly less active compared with non-white children, which was consistent with other reports of typically developing preschoolers [14]. Lastly, there were no differences by gender in the present study. This is contrary to what is observed among typically developing children where boys are consistently more active compared with girls [14, 16, 43], but these associations remain unclear among children with disabilities [25].

Another key finding of this study was that children with autism were significantly more active compared with those with developmental delay ($p = 0.01 – 0.04$). Recently, Brian and colleagues observed that disability status may account for nearly 20% of the variance of physical activity among young children [44]. The presence of a disability, in general, is associated with lower levels of activity [21, 45–48]; however, few studies have explored differences in physical activity across disability diagnoses and these studies included participants ranging in age from 6 to 70 years old [49, 50]. It is unclear as to why children with autism in the present study were more active than those with developmental delay as there were no significant differences between groups in the level of impairment, age, gender, or race. Some studies posit that children with autism engage

in repetitive, stereotypic behaviors which might inflate physical activity [24, 33, 45]. Direct or video observation methodologies would need to be employed to further examine this phenomenon.

In this study, impairments in motor skill and overall adaptive behavior among children with disabilities were not found to be associated with physical activity. Motor skill deficits have been frequently observed among children with disabilities and are hypothesized to influence physical activity behaviors [33, 44, 51–53]. Among typically developing children, there is a consistent, positive association between motor skill competency and physical activity; however, this relationship is not as clear among preschoolers with disabilities and the literature is sparse [33, 44]. Similarly, little is known about how impairments in adaptive behavior associate with physical activity but some studies have observed lower levels of activity among those with greater impairments [26, 27, 49, 50, 54].

Overall, this study makes a unique contribution to the literature as it describes the physical activity behaviors of a diverse sample of preschoolers with disabilities during the preschool day. Sample homogeneity has been a shortcoming in previous studies, but our sample was comprised of an equal number of white and non-white participants and had a larger proportion of girls to boys than typically reported [25]. The use of accelerometry to directly measure physical activity was a considerable strength of the study. Further, where previous studies have reported difficulty using accelerometers among children with disabilities [30, 55], we experienced a high degree of compliance among participants. Another strength of the study was that the VABS-3 was administered as a parent interview to assess children's adaptive behavior skills. This methodology was

selected to reduce instances of under- or over-reporting adaptive behavior skills which is more likely to occur using a parent/caregiver form [32].

In addition to the strengths of the study, there are several limitations which should be considered. First, data were collected on a small, convenience sample of children with disabilities. But, this sample size is comparable to other studies that have focused on preschool-aged children with disabilities [33, 44, 56]. Next, physical activity was only assessed during the preschool day. As such, the observed child-level predictors may not generalize across other settings, and it is unclear how physical activity during the preschool day contributes to overall daily activity. Most of the preschoolers in the present study attended a special education classroom and few children were in an inclusive classroom. Due to the small sample size, we were unable to explore differences in physical activity between these two classroom types, but this is worthy of exploration in future studies. Lastly, despite several attempts to reach families for the VABS-3 interviews, four families did not complete the protocol. This reduced our sample size and potentially affected our ability to detect differences in physical activity by adaptive behavior and motor skill impairment levels.

Conclusion

Overall, young children with developmental disabilities and delays spent approximately 25% of the time in light, moderate, and vigorous physical activity during the preschool day. The preschool a child attended accounted for nearly half of the variance in physical activity and several child level factors associated with moderate-to-vigorous and total physical activity. Future studies should further explore these factors as well as disability-specific characteristics that associate with physical activity among

larger samples of preschoolers with developmental disabilities. Preschool settings have the potential to greatly influence physical activity behaviors of young children with and without disabilities and are a promising setting for intervention. However, additional research is warranted in order to understand how the specific preschool policies and practices contribute to the wide variability in physical activity among preschoolers with disabilities.

Table 3.1. Demographic characteristics and physical activity levels of study participants.

	Total	Autism	Developmental Delay	p-value
n	34	16	18	
Age, years (SD)	4.28 (±1.07)	4.39 (±1.03)	4.18 (±1.12)	0.57
Gender, % male (n)	64.71 (22)	75.00 (12)	55.56 (10)	0.24
Race/Ethnicity, % (n)				0.34
White	50.00 (17)	50.00 (8)	50.00 (9)	
Black/African American	32.35 (11)	37.50 (6)	27.78 (5)	
Hispanic/Latino White	8.82 (3)	--	16.67 (3)	
Other or more than one race	8.82 (3)	12.50 (2)	5.56 (1)	
Parent Education Status, % (n)				0.60
High School or Less	20.59 (7)	25.00 (4)	16.67 (3)	
Associates or College	70.59 (24)	62.50 (10)	77.78 (14)	
Graduate School or Above	8.82 (3)	12.50 (2)	5.56 (1)	
Level of Impairment, % (n)				0.73
Less Impaired	46.67 (14)	50.00 (7)	43.75 (7)	
More Impaired	53.33 (16)	50.00 (7)	56.25 (9)	
Adaptive Behavior Composite, mean (SD)	68.83 (±11.32)	67.29 (±14.46)	70.19 (±7.91)	0.51
Vineland Summary Scores, mean (SD)				
Daily Living Skills	69.93 (±9.10)	68.50 (±19.62)	71.19 (±7.66)	0.43
Communication Skills	63.13 (±20.17)	60.36 (±26.50)	65.56 (±12.83)	0.51
Social Skills	75.30 (±11.64)	74.57 (±13.55)	75.94 (±10.09)	0.75
Motor Skills	73.53 (±11.37)	75.36 (±12.26)	71.94 (±10.66)	0.42
Percent Time in Physical Activity, mean (SD)				
Sedentary	74.73 (±8.14)	70.38 (±8.60)	78.60 (±5.45)	**<0.01**
Light	12.35 (±3.06)	13.45 (±3.37)	11.38 (±2.46)	**0.05**
MVPA	12.92 (±5.78)	16.18 (±6.18)	10.03 (±3.51)	**<0.01**
TPA	25.27 (±8.14)	29.62 (±8.60)	21.40 (±5.45)	**<0.01**

Table 3.2. One-way ANOVA for Physical Activity Covariates

		Physical Activity (min/hr)											
		Sedentary			Light			MVPA			TPA		
	N	Mean	SD		Mean	SD		Mean	SD		Mean	SD	
Gender													
Male	22	44.03	5.50	(P = 0.20)	7.70	1.97	(P = 0.22)	8.27	4.00	(P = 0.24)	15.97	5.50	(P = 0.20)
Female	12	46.31	3.17		6.88	1.52		6.80	2.02		13.69	3.17	
Race													
White	17	45.01	4.70	(P = 0.84)	7.39	1.83	(P = 0.95)	7.76	3.31	(P = 0.80)	14.99	4.70	(P = 0.84)
Non-white	17	44.66	5.20		7.43	1.90		7.91	3.71		15.34	5.20	
Primary Diagnosis													
Autism	16	42.23	5.16	**(P < 0.01)**	8.07	2.02	**(P = 0.05)**	9.71	3.71	**(P < 0.01)**	17.77	5.16	**(P < 0.01)**
Developmental Delay	18	47.16	3.27		6.83	1.48		6.02	2.11		12.84	3.27	
Level of Impairment													
Less Impaired (ABC>70)	14	45.61	5.80	(P = 0.70)	7.2	2.06	(P = 0.89)	7.18	3.97	(P = 0.64)	14.39	5.80	(P = 0.70)
More Impaired (ABC ≤70)	16	44.88	4.28		7.3	1.45		7.82	3.36		15.12	4.28	
Motor Skills													
Less Impaired (>70)	18	44.67	5.84	(P=0.46)	7.34	1.96	(P=0.75)	8.00	4.31	(P=0.39)	15.33	5.84	(P=0.46)
More Impaired (≤70)	12	46.06	3.35		7.12	1.39		6.81	2.18		13.94	3.35	
Parent Education													
High School	7	42.38	3.29	(P = 0.26)	8.62	1.74	**(P = 0.03)**	9.00	2.57	(P = 0.58)	17.62	3.29	(P = 0.26)
Associates/College	24	45.24	5.01		7.31	1.72		7.45	3.54		14.76	5.01	

Graduate School	3	47.37	6.31		5.38	1.13		7.25	5.27		12.63	6.31	
School													
1	8	44.53	2.75	**(P < 0.01)**	7.31	1.44	(P = 0.14)	8.15	2.18	**(P < 0.01)**	15.47	2.75	**(P < 0.01)**
2	6	46.42	4.98		7.29	2.54		6.28	2.51		13.57	4.98	
3	7	47.76	4.03		6.62	1.34		5.62	2.80		12.24	4.03	
4	5	37.68	3.23		9.29	2.06		13.02	2.44		22.32	3.23	
5	8	45.85	4.31		7.71	1.14		7.03	3.21		14.15	4.31	

Table 3.3. Mixed models predicting time (min/hr) in moderate-to-vigorous physical activity (MVPA) and total physical activity (TPA) with school as a random effect.

		MVPA					TPA				
		Estimate	Standard Error	F Value	p-value	BIC	Estimate	Standard Error	F Value	p-value	BIC
Model 1	Intercept	0.922	2.435	-	0.72	151.1	5.104	3.505	-	0.22	174.8
	Age, years	1.347	0.407	10.93	**<0.01**		2.040	0.615	11.00	**<0.01**	
	Gender (male)	-1.416	0.746	3.60	0.07		-2.158	1.129	3.65	0.07	
	Race (white)	3.557	0.828	18.44	**<0.01**		1.252	1.252	14.44	**<0.01**	
Model 2	Intercept	2.491	2.252	-	0.33	143.2	7.208	3.336	-	0.10	167.5
	Age, years	1.245	0.376	10.97	**<0.01**		1.907	0.584	10.67	**<0.01**	
	Gender (male)	-1.200	0.690	3.02	0.09		-1.857	1.076	2.98	0.10	
	Race (white)	3.198	0.770	17.24	**<0.01**		4.254	1.197	12.63	**<0.01**	
	Primary Diagnosis (ASD)	-2.025	0.748	7.33	**0.01**		-2.737	1.159	5.58	**0.03**	
Model 3	Intercept	2.557	2.441	-	0.35	125.4	7.439	3.606	-	0.11	144.4
	Age, years	1.221	0.446	7.50	**0.01**		1.735	0.666	6.78	**0.02**	
	Gender (male)	-1.013	0.771	1.72	0.20		-1.164	1.153	1.02	0.32	
	Race (white)	3.233	0.902	12.85	**<0.01**		4.098	1.347	9.25	**0.01**	
	Primary Diagnosis (ASD)	-1.939	0.857	5.12	**0.04**		-1.903	1.278	2.22	0.15	
	Impairment Level (Less impaired)	-0.279	0.790	0.13	0.73		-0.594	1.181	0.25	0.62	
Model 4	Intercept	2.398	2.522	-	0.40	122.7	7.544	3.754	-	0.11	141.0
	Age, years	1.285	0.493	6.80	**0.02**		1.694	0.732	5.35	**0.03**	
	Gender (male)	-0.781	1.070	0.53	0.47		-1.321	1.592	0.69	0.42	
	Race (white)	3.204	0.926	11.98	**0.00**		4.110	1.376	8.92	**0.01**	
	Primary Diagnosis (ASD)	-2.017	0.895	5.08	**0.04**		-1.859	1.331	1.95	0.18	
	Impairment Level (Less impaired)	-0.182	0.862	0.04	0.83		-0.659	1.282	0.26	0.61	

	Motor Skill Level (Less impaired)	-0.459	1.425	0.10	0.75		0.309	2.120	0.02	0.89	
Model 5	Intercept	0.457	3.559	-	0.90	115.8	9.653	5.085	-	0.13	130.8
	Age, years	1.348	0.513	6.89	**0.02**		1.467	0.734	4.00	0.06	
	Gender (male)	-1.224	1.157	1.12	0.31		-1.162	1.654	0.49	0.49	
	Race (white)	3.646	1.135	10.33	**0.01**		3.351	1.622	4.27	**0.05**	
	Primary Diagnosis (ASD)	-2.028	0.933	4.72	**0.04**		-2.444	1.333	3.36	0.08	
	Impairment Level (Less impaired)	0.380	1.050	0.13	0.72		-0.926	1.501	0.38	0.55	
	Motor Skill Level (Less impaired)	-0.608	1.439	0.18	0.68		-0.116	2.056	0.00	0.96	
	Parent education (High School)	-	-	0.89	0.43		-	-	1.85	0.19	
	Associates/College	1.736	1.541	-	-		0.255	2.202	-	-	
	Graduate School	0.964	2.229	-	-		-3.537	3.186	-	-	

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CHAPTER 4

PRESCHOOL ENVIRONMENTAL FACTORS ASSOCIATED WITH PHYSICAL ACTIVITY IN YOUNG CHILDREN WITH DEVELOPMENTAL DISABILITIES

Abstract

Purpose: The purpose of this study was to describe the associations between features of the preschool physical and social environment on physical activity behaviors of young children with developmental disabilities.

Methods: A sample of 34 preschool-aged children (M_{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 (OSRAC-DD). 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 (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 (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 to in groups with an adult present.

Conclusion: Certain characteristics of the preschool physical and social environment were more conducive to physical activity than others. Children with disabilities would benefit from more time outdoors and in smaller group settings during preschool.

Introduction

In the United States, the prevalence of children with diagnosed developmental disabilities has increased in recent years, affecting approximately one in 6 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, 4]. 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 [5–7]. Improving participation in physical activity during the early childhood years can result in significant health and developmental benefits [8, 9]. The *2018 Physical Activity Guidelines for Americans* recommends that young children (ages 3 – 5 years) accumulate at least 3 hours of light, moderate, and vigorous physical activity each day through structured and unstructured play [10]. Despite this recommendation, physical activity levels are low among young children with and without disabilities [11–14].

Approximately 60% of 3- to 5-year old children in non-parental childcare arrangements attend a center-based program, hereafter referred to as preschools, for an average of 23 hours per week [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, 18]. In a recent study, Costanzo and Magnuson 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 [18]. As such, preschool settings reach a

considerable number of young children with disabilities and are uniquely positioned to provide opportunities for physical activity participation.

Previous studies have demonstrated that the preschool a child attends accounts for a significant amount of the variance in daily physical activity [19, 20]. This variability may be related to the policies and practices within preschools [21–23]. It may also be attributed to the numerous behavior settings, in which children interact during the preschool day [24]. Behavior settings are described as ecological units bound by space and time within which people and the environment interact, resulting in patterns of behavior [24, 25]. Within preschool behavior settings, such as group time, outdoor play, and center activities, children interact with features of the physical and social environment, consequently impacting physical activity levels. For example, it is well known that preschoolers are more active when they are outdoors compared with indoors [26, 27]. Cosco et al. 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 [24]. Other studies have observed higher levels of physical activity during child- versus adult-initiated playground activities and in smaller social group contexts [27, 28]

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 to when in social groups [29]. School-aged children with developmental disabilities have been observed to be less active in structured physical education settings compared to free play, and this

varied by lesson context [30, 31]. 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 that may exist between features of the preschool environment and physical activity of young children with developmental disabilities.

Methods

Participants and Setting

Participants were recruited from preschools (n=5) in a southeastern state. Children were enrolled in inclusive or special education classrooms that were comprised of 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 below), had significant physical or medical impairments that hindered movement, and did not attend preschool at least three days per week. Parents and guardians of 38 children consented to the study, however four were excluded due to the absence of a formal diagnosis. Most children had more than one diagnosis, but primary diagnoses for the 34 participating children (64.7% male; mean age = 4.28±1.07 years) 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 4.1. 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 [32]. Parents reported the type of healthcare provider that diagnosed their child and selected the specific developmental disability or delay diagnoses from a list of twelve. For special education services, parents reported whether their child received early intervention services through an Individualized Family Service Plan, and if these services began prior to age 3 years. 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 [33]. Evaluating adaptive 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) [33] as a semi-structured 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 through age 90 years across several key domains including: communication skills, socialization skills, daily living skills, motor skills, and maladaptive behaviors [33]. 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.

Observation System for Recording Physical Activity – Developmental Disabilities

The Observation System for Recording Physical Activity – Developmental Disabilities version (OSRAC-DD) was used to assess physical activity behaviors in children with disabilities. This instrument was developed to measure physical activity levels, the types of activity, and repetitive/stereotypic behaviors across preschool social and physical environmental contexts. Physical activity level codes were drawn from other observation instruments [34, 35] 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 have been validated for populations of young children with and without disabilities [35, 36].

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, 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 Observational System for Recording Physical Activity in Children – Preschool version (OSRAC-P) [34], 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.

Procedures

Prior to 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. 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 minutes in duration and were comprised of 30-second coding intervals. Each 30-second coding interval consisted of a 5-second observation followed by a 25-second 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 [37]. Observers wore headphones and listened to audio prompts to indicate the 5-second observation and 25-second record periods. At the end of the 5-second 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. [34] and included informal observations, memorizing codes, definitions, and protocol, debriefing

sessions, and *in situ* observations. The reliability study began after observers achieved at least 80% agreement on all coding categories during *in situ* observations. Inter-rater 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. Inter-rater reliability was determined by calculating percent agreement and Cohen's kappa for each observation category. Percent agreement ranged from 82% to 99% and kappa values ranged from 0.77 to 0.99 indicating adequate reliability across all categories (see Table 4.2).

Analysis

Descriptive statistics were calculated for participant characteristics and are presented in Table 4.1. VABS-3 qualitative descriptors were applied to ABC scores and motor skill scores to classify the level of impairment [33]. 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 4.3. Pearson's chi-square analyses were conducted to determine differences in MVPA and TPA by gender, age (younger, ≤4.5 years; older, ≥4.5 years), 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, 6) group composition and interaction. All models were adjusted for age, gender, 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 minutes 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 (see Table 4.3).

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 five 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. 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 did not interact with others during 56.4% 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 gender [X^2_{mvpa} (1, 11036) = 2.8, p =0.09; X^2_{tpa} (1, 11036) = 0.6, p =0.45], age [X^2_{mvpa} (1, 11036) =0.7, p =0.42; X^2_{tpa} (1, 11036) = 0.7, p =0.39], race [X^2_{mvpa} (1, 11036) = 0.0, p =0.96; X^2_{tpa} (1, 11036) = 0.3, p =0.59], diagnosis [X^2_{mvpa} (1, 11036) = 3.5, p =0.06; X^2_{tpa} (1, 11036) = 0.9, p =0.34], or level of impairment [X^2_{mvpa} (1, 9768) = 0.3, p =0.60; X^2_{tpa} (1, 9768) = 0.9, p =0.35]. Compared to children with greater motor skill impairments, children who were less impaired in motor skills spent more time in MVPA [X^2_{mvpa} (1, 9768) = 8.0, p =0.005]. This finding did not hold for TPA [X^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, gender, diagnosis, and motor skill level and results are presented in Table 4.4. 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 to 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 (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 to any other social setting (see Table 4.4). Logistic regression analyses were not conducted for the physical activity prompt category due to 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 significantly associated with

physical activity in this sample of children. First, children in this study were more likely to be physically active outdoors compared to indoors. These findings are consistent with studies of typically developing preschool children [26–28, 38]. 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 [31, 39, 40]. Sit and colleagues observed that compared to structured play opportunities, the unstructured nature of free play was more conducive to physical activity among school-aged children with physical and developmental disabilities [30]. Another study found that classroom management strategies considerably limited the amount of time children with autism spent in physical activity during structured physical education [39]. 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 to when using fixed playground equipment. These findings were similar to those among typically developing preschoolers [28].

Another important finding of this study was that the preschool day was primarily comprised of 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 [26]. Importantly, these children were 5 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 [27, 28, 41]. Overall, the therapy settings appeared 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 to 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 [41]. Similarly, other studies have concluded that smaller group settings, in general, are more conducive to physical activity [27–29, 42]. 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, for instance, observed lower levels of physical activity among children with autism who had more significant social impairments compared to those who were less impaired [43]. Further, these social impairments are frequently cited by parents of children with disabilities as a barrier to physical activity participation [44, 45].

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 non-invasive assessment of physical activity and avoided potential difficulties often associated with using devices like pedometers and accelerometers in studies of individuals with disabilities [46]. An additional strength was the random allocation of participants and observers to observation sessions, as well as the high levels of inter-rater reliability. Lastly, though small, this sample is among the most diverse in studies of preschool-aged children with disabilities as half of the participants were non-white and over one third of the sample was comprised of females.

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. Further, 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 Children's Activity Rating Scale but have only been validated for typically developing preschoolers and a small sample (n=5) of children with disabilities [35, 36]. However, there is no significant reason to believe that children with developmental disabilities and delays are physiologically different from their peers. 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.

Conclusion

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 certain 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.

Table 4.1. Demographic characteristics and physical activity levels of study participants.

	Total
n	34
Age, years (SD)	4.28 (±1.07)
Gender, % 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	
Autism	47.1% (16)
Developmental and learning delays	23.5% (8)
Down syndrome	20.6% (7)
Other	8.8% (3)
Adaptive Behavior Composite, 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)

Table 4.2. Average kappa coefficients and interobserver percent agreement by OSRAC-DD coding category.

		Mean	SD
Physical Activity Level	Kappa	0.77	0.12
	Percent Agreement	0.82	0.11
Physical Activity Type	Kappa	0.90	0.09
	Percent Agreement	0.90	0.09
Stereotypic/Maladaptive Behavior	Kappa	0.96	0.08
	Percent Agreement	0.96	0.08
Location	Kappa	0.99	0.03
	Percent Agreement	0.99	0.02
Indoor Activity Context	Kappa	0.95	0.09
	Percent Agreement	0.95	0.09
Outdoor Activity Context	Kappa	0.98	0.04
	Percent Agreement	0.98	0.04
Activity Initiator	Kappa	0.95	0.12
	Percent Agreement	0.97	0.08
Group Composition	Kappa	0.89	0.11
	Percent Agreement	0.90	0.08
Interaction	Kappa	0.77	0.19
	Percent Agreement	0.89	0.07
Prompts	Kappa	0.95	0.20
	Percent Agreement	0.99	0.03
Reactivity	Kappa	0.98	0.04
	Percent Agreement	0.98	0.04

Table 4.3. Number of observed intervals and percentages observed in sedentary, light, and moderate-to-vigorous physical activity (MVPA) by OSRAC-DD category.

Categories, Observed Codes	Observed Intervals	Sedentary	Light	MVPA
Total Observed Intervals	11310	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	10480	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	10955	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

Table 4.4. Logistic regression analyses for environmental contexts and total physical activity (TPA) among preschoolers with disabilities.

		TPA	
	% Level	OR	95% CI
Repetitive/Stereotypic Behavior (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, gender, diagnosis, and motor skills. 1255 observation intervals were excluded due to missing motor skill information from the Vineland-3. OR = odds ratio. CI = confidence interval.

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CHAPTER 5

OVERALL DISCUSSION

Significance

Empirical evidence demonstrates that children with disabilities are less physically active compared with typically developing peers [1–3]. Regular participation in physical activity is associated with positive health, cognitive, and behavioral outcomes among children with and without disabilities [4–7]. Given that physical activity behaviors track into adulthood, promoting physical activity during early childhood is critical. Over a third of preschool-aged children with developmental disabilities are enrolled in a center-based preschool program and spend on average 23 hours per week in care [8–10]. Recent physical activity guidelines state that preschools should provide opportunities for children to be physically active for at least 15 minutes per hour each day [4]. However, little is known about the physical activity behaviors of children with disabilities in preschool. Given that young children with disabilities spend a considerable amount of time in preschool settings, it is important to investigate patterns of and factors that associate with physical activity among these children in preschools.

Physical activity behaviors are directly and indirectly influenced by a variety of factors across multiple levels including individual, intrapersonal, and environmental levels [11–13]. The correlates of physical activity among typically developing children have been well-documented and can be grouped into these three levels based on the socio-ecologic framework [11–14]. Some key individual-level factors, such as age and gender, have been found to associate with physical activity of children with disabilities [15–17]. The presence of a disability and additional comorbidities is associated with lower levels of physical activity among these children [17]. Moreover, children with disabilities often demonstrate impairments in social and motor skills which have been

observed to impact participation in physical activity [18–22]. Importantly, individual-level factors have rarely been investigated among preschool-aged children with developmental disabilities.

The preschool setting accounts for a large proportion of variability in physical activity [23, 24]. Throughout the preschool day, children are exposed to a variety of social and behavioral settings such as small or large groups, center time activities, outdoor play, and manipulative play within which physical activity may occur. Such behavioral settings are comprised of social and physical environmental characteristics that associate with physical activity. For example, children with disabilities tend to spend less time engaging with peers during physical activity settings [25], and previous studies have found that certain social environmental factors, such as group size, significantly influences physical activity participation [26, 27]. Moreover, there is emerging evidence that features of the physical environment and lack of developmentally appropriate, accessible programs influence and limit opportunities for young children with disabilities to participate in physical activity [28–33].

Physical activity is a multidimensional behavior that is influenced by factors across numerous ecological levels. In order to develop comprehensive approaches to promoting physical activity among children with disabilities, it is necessary to identify factors that associate with physical activity in settings within which they spend time. To date, little is known about the physical activity behaviors of young children (ages 3 – 5 years) with disabilities or the influences of preschool environmental characteristics on physical activity.

Purpose

This dissertation addressed several gaps in the literature by describing the physical activity behaviors of preschoolers with developmental disabilities as well as child- and preschool environmental-level factors that associate with physical activity. The purpose of the first study was to develop a reliable direct observation instrument that could be used to assess physical activity behaviors of preschoolers with disabilities and environmental characteristics of the preschool setting. The purpose of the second study was twofold: to describe overall levels of physical activity among preschoolers with disabilities during the preschool day, and to identify the association between physical activity and select child-level variables. The purpose of the third study was to investigate whether features of the social and physical environment associate with physical activity among children with disabilities in the preschool setting.

Design and Methods

A cross-sectional study design was used in all three observational studies that are included in this dissertation. In the first study, literature reviews, informal observations, and expert consultations were conducted to inform the development of a new observation instrument, the OSRAC-DD. A convenience sample of nineteen children with disabilities from preschools in two southeastern cities were recruited to participate in the study. The primary aim of this study was to determine the reliability of the OSRAC-DD. This was achieved by two observers following the same focal child while simultaneously but independently recording observations. In the second study, a convenience sample of thirty-four children with disabilities was recruited from preschools in three southeastern cities and five preschools. The dependent variables were accelerometry-derived

moderate-to-vigorous and total physical activity. Selected child-level covariates included age, gender, race, parent education, diagnosis, level of impairment, and motor skill impairment. Most covariates were reported by the parents and guardians in a parent survey. Level of impairment and motor skill impairment were determined through semi-structured interviews using the Vineland Adaptive Behavior Scales, Third Edition. The third study utilized the OSRAC-DD to assess and describe the patterns of physical activity and associated features of the preschool physical and social environment. The dependent variable was percentage of intervals spent in total physical activity. Logistic regression models were adjusted for age, gender, diagnosis, and motor skill level, and child nested within school was included as a random effect.

Major Findings

Overall, the findings of this dissertation support a multilevel approach towards understanding and intervening upon physical activity behaviors of preschoolers with developmental disabilities. A common finding among all three studies was that young children with disabilities were primarily sedentary during the preschool day, similar to previous reports of typically developing preschoolers [24]. In the first study, the major finding was that the OSRAC-DD was a reliable instrument for assessing physical activity behaviors of preschoolers with disabilities and the corresponding preschool contexts. This direct observation instrument was a non-invasive method of estimating physical activity of young children with disabilities who may otherwise be sensitive to external monitoring devices [34]. Most importantly, the OSRAC-DD permitted the simultaneous recording of behavioral contexts within which physical activity took place. Other observation systems that have been used to directly observe physical activity behaviors of

children with disabilities were either not specific to the preschool setting [33, 35] or did not account for all contextual circumstances that occur in preschools for children with disabilities [36]. The OSRAC-DD can be used to assess physical activity behaviors of preschoolers with and without developmental disabilities and delays in inclusive or special education preschool settings. Further, it has demonstrated high reliability, similar to other comparable physical activity observation instruments for young children [35, 36].

In the second study, results indicated that the preschool setting accounted for nearly half of the variance in physical activity among children with disabilities. This suggests that certain characteristics of the preschool environment may be more supportive of physical activity than others. Additionally, the present study found that important child-level demographic variables including age, race, and diagnosis were significantly associated with physical activity. These findings extend the literature as few studies of physical activity among children with disabilities have included samples of preschool-aged children [34, 37, 38]. Identifying factors that associate with physical activity beginning in early childhood can help in understanding patterns of physical activity over time and can inform intervention efforts. For example, in this study older preschool-aged children with disabilities were more active than younger children with disabilities; however, the literature has consistently demonstrated declines in physical activity among school-aged children with disabilities as they age [15, 16]. There may be a point at which the relationship between age and physical activity shifts during early childhood, resulting in declining physical activity over subsequent years. It is at this point where physical activity intervention may be most critical for children with disabilities.

The finding that children with autism were more physically active compared to those with diagnosed developmental delays was novel. Previous research has demonstrated associations between physical activity and levels of social and motor skill impairment [18, 21, 39, 40]; however, these associations were not observed in this study. It may be that the sample was too small to detect differences in physical activity by level of impairment or that these associations do not emerge until after early childhood.

The third study observed significant associations between physical activity and features of the physical and social environment. For example, greater levels of physical activity were observed in therapy sessions, outdoors, and in smaller group settings. These findings extend those of Study 2 and together they provide evidence that physical activity behaviors of children with developmental disabilities are influenced across multiple levels, consistent with the socio-ecological model. Consistent with previous studies on children with autism [25–27], it is unlikely that individual- and environmental-level variables independently associate with physical activity. Rather, individual-level characteristics, such as diagnosis, likely interact with features of the social and physical environment, resulting in physical activity behaviors. Collectively, the results of this dissertation provide a comprehensive account of the physical activity patterns of children with developmental disabilities in preschool settings and support the need for ecological approaches to physical activity promotion.

Limitations

There are several limitations of this dissertation that should be considered. First, these studies utilized small, convenience samples of children. Although these sample sizes are similar to other studies in the literature [41, 42], they may have limited the

ability to detect associations between certain covariates (e.g., level of impairment, gender) due to statistical power. Next, the samples in this dissertation were primarily comprised of children with an autism diagnosis. Thus, results of these studies may not be generalizable to children with other developmental disability diagnoses. Another limitation of this dissertation was the use of physical activity measurement tools that have not been rigorously validated for children with disabilities. In studies one and three, OSRAC-DD physical activity level codes are based on the Children's Activity Rating Scale (CARS) which rates physical activity intensity on a scale of 1 to 5 [43]. The validity of CARS among typically developing preschoolers is well established [43], however the scale has only been validated among a small (n=5) sample of children with cerebral palsy [44]. Lastly, the second study used the Pate et al. cut points to estimate accelerometry-derived levels of physical activity. These cut points have not been validated for children with disabilities, but have been used by other researchers to describe physical activity behaviors of young children with disabilities [41, 42].

Practical Implications

Preschool teachers and directors should recognize the importance of physical activity for young children with and without disabilities. Further, provision of inclusive physical activity opportunities must be a high priority among preschools. Preschool directors and administrators should support teachers in participating in professional development activities that enhance knowledge and competence around incorporating physical activity into the preschool day. Teachers without a background in early childhood special education may also benefit from training on how to modify activities to better suit children with developmental disabilities. Results of this dissertation revealed

numerous similarities between physical activity behaviors among children with disabilities and typically developing peers during the preschool day. As such, it seems reasonable to conclude that many existing physical activity strategies and interventions can be modified to include children with developmental disabilities [37]. Specifically, children with disabilities in preschool settings would benefit from: 1) numerous physical activity opportunities offered throughout the day, especially in outdoor environments, 2) access to portable play equipment and balls, and 3) an intentional restructuring of the social environment to include smaller groups of children or one-on-one support.

Considerations for Future Research

Findings from this dissertation provide evidence of the importance of the preschool setting for physical activity promotion in young children with disabilities. Wide variability in physical activity levels across preschools was observed in these studies and may be attributed to physical and social environmental characteristics. This variability may also be explained by preschool policies and practices, such as written, preschool-specific physical activity policies, requirements for highly trained staff, and frequency of physical activity opportunities. These policies and practices were not investigated in this dissertation, but it is important that future studies explore how they influence physical activity of children with disabilities. Additionally, the studies included in this dissertation did not assess daily physical activity in settings and times outside of the preschool day (e.g., home, weekend activities). As such, it remains unclear how the amount of physical activity acquired during the preschool setting contributes to overall levels of physical activity.

The studies in this dissertation and previous studies of individual-level factors associated with physical activity among preschoolers with disabilities employed cross-sectional designs. These studies have identified important demographic variables that associate with physical activity among this population, but it is unclear how they associate with physical activity over time. Future studies should employ longitudinal investigations of physical activity among children with disabilities beginning in early childhood. Specifically, the associations between individual-level factors such as age and motor skills should be further explored as they appear to be most consistently associated with physical activity in children with disabilities. Additionally, studies should investigate the differences in physical activity by developmental disability diagnoses and consider the influence of impairments in social skills, communication skills, and daily living skills across diagnoses. It may be that adaptive behavior skills modify the relationship between diagnosis and physical activity, but these associations must be explored in larger samples of children. Lastly, the relationships between physical activity and individual- and environmental-level factors were examined independently of one another in this dissertation. Given the multilevel influences on physical activity behaviors, future studies should investigate potential interactions between these factors and physical activity behaviors of children with disabilities.

Conclusions

The studies in this dissertation addressed several gaps in the literature and were the first to thoroughly describe physical activity behaviors among young children with disabilities in the preschool setting. Overall findings suggest that physical activity behaviors among these children are influenced by a variety of factors across social-

ecological levels. Additionally, preschools were found to be important settings for the promotion of physical activity in children with disabilities. When designing interventions for young children with developmental disabilities, it is necessary to take a comprehensive, multidimensional approach and consider factors that influence physical activity across a variety of levels. Results of this dissertation highlight the importance of providing ample opportunities for physical activity in supportive environments during the preschool day so as to facilitate health-promoting levels of physical activity in children with developmental disabilities.

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CHAPTER 6

PROPOSAL

Introduction

Prevalence of childhood obesity is the highest it has been in decades and, given its association with numerous negative health outcomes, it is a major public health concern in the United States. Currently approximately 17% of children are considered obese [1] and without preventative efforts, childhood obesity could persist into adulthood [2]. Unfortunately, a sub-sample of the general population is often excluded from obesity prevention efforts: children with developmental disabilities. Recent studies have found a higher prevalence of overweight and obesity among this population (Bandini et al., 2015; De, Small, & Baur, 2008; Rimmer, Rowland, & Yamaki, 2007) and by the age of three, children with developmental disabilities are already at a greater risk for developing obesity compared to their typically developing peers [6].

One factor that has consistently been associated with childhood obesity is physical activity, that is any bodily movement that requires energy expenditure [7, 8]. Physical activity can aid in obesity prevention, improve body composition, enhance muscle and bone development, prevent the development of numerous conditions such as type II diabetes and hypertension, and enhance quality of life [9]. Emerging evidence suggests that physical activity is also associated with improvements in cognitive functioning among typically developing children [10] and reductions in repetitive and maladaptive behaviors among children with developmental disabilities [11]. Regular participation in physical activity is so vital for children's health and development that federal initiatives and surveillance efforts have been launched in order to enhance and monitor children's physical activity behaviors.

In 2008, the first *Physical Activity Guidelines for Americans* was released by the United States Department of Health and Human Services (USDHHS, 2008). Based on decades of research and reviews from expert committees, the physical activity guidelines provide guidance on improving health outcomes through physical activity. The guidelines state that for children to obtain the health benefits of physical activity, they should participate in at least 60 minutes of daily moderate-to-vigorous physical activity and at least 2- to 3-days per week of muscle- and bone-strengthening exercises. Although the *2008 Physical Activity Guidelines for Americans* did not offer recommendations for children of preschool age (ages 3 – 5 years), the Institute of Medicine (IOM) recommends that preschool-aged children acquire at least 15 minutes of physical activity at any level of intensity (including light, moderate, and vigorous) per waking hour [12].

The *Physical Activity Guidelines for Americans* and the IOM report on preschoolers' physical activity set attainable goals for physical activity promotion and interventions. Using these guidelines, researchers and practitioners alike continually monitor and evaluate physical activity participation of children over time. Regular physical activity surveillance has provided invaluable data on the physical activity patterns, types and contexts among typically developing children. This information can be and has been used to inform physical activity intervention and policy efforts. Unfortunately, children with developmental disabilities are often excluded from regular surveillance efforts and ultimately from conversations about physical activity and health. For example, the *Physical Activity Guidelines Report* (USDHHS, 2008) only briefly states that children with developmental disabilities are more likely to be inactive and that

they should strive to achieve the same physical activity recommendations as typically developing children.

More recently, however, *Healthy People 2020* emphasized the importance of enhancing health through physical activity participation for all American children, including those with disabilities (Healthy People, 2010). To do so, additional research is necessary to understand the patterns, types, and contexts of physical activity among this population. Children with developmental disabilities are already an underserved population that experiences poorer health outcomes and lower levels of physical activity compared with those of typical development. Such disparities, like obesity, can begin to develop as early as the preschool years. It is therefore critical to explore and address physical activity during the early childhood years.

Statement of the problem

This dissertation aims to advance researchers' knowledge and understanding of the physical activity behaviors of preschoolers with developmental disabilities during preschool, a setting in which many children with and without disabilities spend their time. Further, this project will identify potential correlates of physical activity behaviors among this population, which will inform promising areas for future interventions. Specifically, the proposed project will:

a. Develop a physical activity observational instrument that is appropriate for studying physical activity of preschoolers with developmental disabilities in the preschool setting.

b. Determine the amount of time preschoolers with developmental disabilities spend in total physical activity and moderate-to-vigorous physical activity during the preschool day.
c. Explore associations between physical activity behaviors of preschoolers with developmental disabilities and social environmental features of the preschool setting.
d. Explore associations between the physical activity behaviors of preschoolers with developmental disabilities and physical environmental features of the preschool setting.

Defining Developmental Disabilities

In the United States, approximately 1 in 6 children between the ages of 3 to 17 years old are diagnosed with a developmental disability [13]. Children with developmental disabilities include those with Down syndrome, Cerebral Palsy, Autism Spectrum Disorders, Fetal Alcohol Syndrome, Attention-Deficit/Hyperactivity Disorder, Intellectual Disability, and other diagnoses that demonstrate impairments in physical, learning, language, and behavioral domains. Developmental disabilities manifest during childhood, before the age of 22 years, and persist into adulthood (Developmental Disabilities Assistance and Bill of Rights Act of 2000, 42 USC § 102). Individuals diagnosed with developmental disabilities demonstrate substantial functional impairments in at least two of the following domains: self-care, receptive and expressive language, mobility, self-direction, learning, capacity for independent living, and the need for planned and coordinated lifelong care[14]. Due to the varying levels of impairments across domains, it is a vastly heterogeneous population.

Federal law mandates that children with developmental disabilities have access to free public education and Individualized Education Programs (IEP) in the least restrictive environment, which may include home-based, traditional school-based, or segregated classrooms, depending on the child's needs (Individuals with Disabilities Education Act [IDEA], 2004). Children who receive special education services through IEPs:

1. Receive certain categories of diagnoses after a standardized evaluation protocol (this consists of evaluations from six sources: general education curriculum progress, general education interventions, records interviews, observations, tests).
2. Are monitored annually by state education departments.

Recently, the South Carolina Department of Education summarized data from the *IDEA Part B Child Count and Educational Environments for School Year 2015-2016* (2017) report and found that 9,432 preschool-aged (3-5 years) children with diagnosed developmental disabilities are receiving special education services through IEPs in South Carolina. Most children (80.5%) are 4- and 5-years old. Of these 9,432 children, 57% and 25% are receiving special education services in a regular or segregated classroom, respectively. Developmental delay and autism are the most prevalent diagnoses among South Carolina preschoolers (37% and 11%, respectively), thus they will be the primary focus of this dissertation. South Carolina's Standards for Evaluation and Eligibility Determination (SEED) outlines the specific steps taken to establish a child's diagnosis as well as the criteria necessary to warrant specific diagnoses (e.g., autism, developmental delay). Young children (< 6 years) in South Carolina may obtain a developmental delay diagnosis if they present impairments in at least one of the following areas: physical, cognitive, communication, social or emotional, or adaptive behavior development.

Autism diagnoses require that children are demonstrating impairments in social interaction, repetitive and stereotypic behaviors, communication, and adverse educational performance.

Health and Developmental Disabilities

Numerous disparities exist between children with developmental disabilities and typically developing peers, affecting both health and developmental outcomes. Individuals with developmental disabilities demonstrate considerably worse physical fitness compared with typically developing populations [15–19]. Further, differences in body composition, cardiorespiratory fitness, and muscle strength tend to vary across the specific developmental disability diagnoses (e.g. intellectual disability, Autism Spectrum Disorder, Down syndrome, etc.) yet the developmental trajectory of physical fitness of children with developmental disabilities is largely unknown [16].

Overall, there is a higher prevalence of overweight and obesity among individuals with developmental disabilities compared with typically developing peers (Curtin, Jojic, & Bandini, 2014; De et al., 2008; Rimmer et al., 2010; Rimmer et al., 2007). However, individuals with certain diagnoses may be at greater risk for developing obesity than others. For instance, adolescents diagnosed with autism or Down syndrome are two to three times more likely to develop obesity compared with typically developing peers, whereas those diagnosed with intellectual disability or cerebral palsy were at similar or less risk of developing obesity compared with typically developing peers (OR = 0.96, 95% CI =0.51, 1.82 and OR = 0.30, 95% CI = 0.13, 0.68, respectively) (Rimmer, Yamaki, Lowry, Wang, & Vogel, 2010). In addition to overweight and obesity, individuals with developmental disabilities often experience numerous secondary health

conditions. In a survey of parents (n = 461) with adolescents diagnosed with an intellectual or developmental disability, Rimmer et al. (2010) found a higher number of obesity-related secondary health conditions including diabetes, high cholesterol, and high blood pressure among obese adolescents with disabilities compared with healthy weight adolescents [21].

Children with developmental disabilities often demonstrate impairments in critical areas of child development which may influence physical activity. For example, many young children with developmental disabilities exhibit significant impairments in motor skill development [22–24], and these skills are consistently, positively associated with physical activity (Figueroa & An, 2017). Recently, researchers investigated the motor skills of toddlers diagnosed with autism (n = 162) and categorized children into three groups based on age: 12 – 24 month group, 25 – 30 month group, and 31 – 36 month group) [25]. The motor skills of children in each age group were considerably behind what is to be expected at that age. Further, this gap was significantly wider among the older toddlers [25]. Other deficits in social behaviors, communication, and daily living skills are demonstrated by this population but the degree of impairment is individual- and diagnosis-dependent [23], and little is known about their influence on physical activity.

Typical therapeutic models for children with developmental disabilities aim to address these impairments, particularly in the domains of daily living, communication, and socialization. Models emphasize goals that range from a “do as much as you can” to “strive to achieve typical functioning” approach [26]. While addressing these domains is certainly essential, outcomes related to children’s physical health should not be overlooked. As previously mentioned, individuals with developmental disabilities are

prone to numerous secondary health conditions over the course of their lives. Though the relationships between physical activity and health outcomes have not been directly examined in children with developmental disabilities, empirical evidence demonstrates that regular participation in physical activity can positively improve health and developmental outcomes, regardless of disability status [27]. Additionally, physical activity can positively influence other desirable outcomes among children with disabilities such as decreased stereotypic behaviors, improved cognition, increased attention, and improved social skills [11, 28].

Physical Activity Patterns of Children with Developmental Disabilities

Physical activity behaviors of children with developmental disabilities are becoming increasingly studied, however the literature lacks sufficient evidence from which to draw conclusions. The heterogeneous nature of populations with developmental disabilities adds additional complexities to study recruitment and the ability to generalize results. Further, there are unique measurement issues to consider when researching physical activity among this population. As such, existing studies have utilized considerably different methodological approaches for estimating physical activity, thus reducing the ability to generalize results.

Some studies have found that children with certain diagnoses of developmental disabilities are less physically active compared to typically developing peers [29–33]. For example, the results of a systematic review found that children with cerebral palsy (ages 5 to 18 years) were 13% to 53% less physically active compared to typically developing peers [30] and this may vary depending on the day of the week [29]. Capio and colleagues (2012) examined the objectively measured levels of physical activity of

school-aged children with (n = 31; mean age = 7.41 ± 2.48 years) and without (n = 31; mean age = 6.61 ± 2.47 years) cerebral palsy using accelerometers, which were programmed to collect data in 15 second epochs. Not only were children with cerebral palsy significantly more active during the weekdays compared to weekend days, but they were significantly ($p < 0.001$) less moderate-to-vigorously physically active compared to typically developing peers, overall [29].

Similar patterns in physical activity behavior have been observed among children with other developmental disability diagnoses. Tyler and colleagues (2014) compared accelerometer-derived levels of physical activity of children with autism (mean age = 12.6 ± 2.3 years) to typically developing peers (mean age = 9.0 ± 1.8 years) and found that children with autism were significantly less active than peers. In that study, the sample of children with autism was older than the control group, but the difference in age was not significant [33]. A study conducted by Einarsson et al. (2015) included physical activity assessment of Icelandic children and adolescents (ages 6 – 16 years) with mild-to-severe intellectual disabilities (n = 91; mean age = 11.9 ± 2.9 years) matched on age and sex with typically developing peers (n = 93; mean age = 11.9 ± 2.7 years). Children wore an accelerometer for up to ten consecutive days, including week- and weekend-days. Results indicated that children with intellectual disabilities did not meet physical activity guidelines and were 40% less active than typically developing controls [31].

Other studies have found that levels of physical activity between disabled and non-disabled children are comparable [34–36]. In 2012, Bandini and colleagues compared objectively measured physical activity of 3- to 11-year old children with an Autism Spectrum Disorder to typically developing children of the same age. Both groups

demonstrated comparable levels of weekly physical activity [34]. These findings were similar to those of another study that found comparable levels of physical activity between children with and without Autism Spectrum Disorders across a variety of settings including recess, physical education, and afterschool settings [35]. Whitt-Glover et al. (2006) found that children (mean age = 7.1 ± 2.1 years) with Down syndrome (n = 28) and their typically developing siblings (n = 30) had comparable levels of overall physical activity; however, those with Down syndrome engaged in less vigorous activity compared with peers [36].

A general consensus is that, similar to typically developing peers, most children with developmental disabilities fail to meet the physical activity guidelines (Carlon et al., 2013; Einarsson et al., 2015; Esposito, MacDonald, Hornyak, & Ulrich, 2012; Pan & Frey, 2006; Pan, Tsai, & Hsieh, 2011; Shields, Dodd, & Abblitt, 2009; Trost et al., 2002) and experience age-related declines in physical activity (Jones et al., 2017; Macdonald, Esposito, & Ulrich, 2011; Memari et al., 2013; Pitetti et al., 2013; Troiano et al., 2008). In a cross-sectional study, a sample of 80 Iranian children (mean age = 9.6 years ± 1.8 years) with Autism Spectrum Disorder children wore an accelerometer for one week [43]. After stratifying by age, there was a significant difference ($p = 0.004$) in overall levels of physical activity between all age groups: 7 – 8 years (n = 23), 9 – 10 years (n = 22), 11 – 12 years (n = 19), and 13 – 14 years (n = 16). The youngest children with Autism Spectrum Disorder had higher levels of physical activity than the other age groups, and the 13 – 14-year-old group demonstrated the lowest levels of physical activity.

Much of the literature, however, is focused on school-aged children and less is known about the physical activity patterns of preschoolers with developmental

disabilities [45–48]. Frey and colleagues (2008) reviewed 19 studies on physical activity and youth with intellectual disabilities, of which 7 studies included preschool-aged children in the study sample [46]. Similarly, in a review by Lang et al. (2010), only 5 children under the age of 6 years were included in the reviewed studies (n = 18) [45, 49]. Most recently, 4 out of 17 eligible physical activity studies in another review [32] included preschool-aged children, two of which included children under the age of 5 years old.

Ketcheson and colleagues (2017) aimed to address this dearth in the literature by exploring objectively measured physical activity and correlates of young children with autism [50]. Young children (ages 24 to 68 months) with and without autism wore an Actigraph accelerometer at the waist for 7 consecutive days to monitor physical activity levels. Children with autism (n = 34; mean age = 47.42 ± 12.81 months) spent approximately 13.1% and 13.2% of the time in light and moderate-to-vigorous physical activity, respectively. This was significantly ($p < 0.001$) greater than time spent in light (10.1%) and moderate-to-vigorous (9.0%) physical activity by typically developing peers (n = 19; mean age = 42.50 ± 10.78 months). Both groups of children spent most of the time in sedentary behavior (autism = 73.61%; typically developing = 80.89%). Overall, this study suggests that preschool-aged children with autism are more active compared to typically developing peers, however certain limitations should be considered. Accelerometer wear time was significantly greater for the typically developing children, influencing the estimates of time spent in physical activity. Further, the children with autism demonstrated considerable impairments and it is unclear as to how much time spent in physical activity was accumulated through stereotypic behavior (e.g. body

rocking, hand flapping, and toe walking). Future studies should explore the influence of comorbid conditions (e.g. ADHD and anxiety) and stereotypic behaviors on physical activity levels [50].

Factors Influencing Preschoolers' Physical Activity Behaviors – An Ecological Perspective

Children with and without developmental disabilities are subjected to numerous internal and external factors, which can directly or indirectly influence physical activity behaviors. Such factors can be organized into ecological models which both explain behavior and inform behavioral intervention [51]. While various iterations of ecological models have been developed and applied over the years, each consistently posits that behavior is influenced by multiple levels including: individual, social, organizational, community, and policy levels [51–53]. Within each level, multiple factors may associate with specific health behaviors, such as physical activity, and some (e.g. social and physical environmental factors) may extend across several levels, thus interacting and influencing behavior. Among typically developing preschool children, various factors across ecological levels have been found to associate with physical activity behavior [54] however less is known about the those that associate with physical activity of young children with developmental disabilities.

Individual Factors

It is well established that individual-level factors such as age, gender, and weight status influence physical activity behaviors of typically developing children and adolescents [29, 30, 36, 54–56]. These factors are becoming increasingly explored among preschool-aged children, with only gender consistently emerging as a correlate of

physical activity among this population [55, 57]. Even less is known about the individual-level factors that associate with the physical activity behaviors of children with developmental disabilities.

Some individual-level factors, such as age and gender, have been explored among populations with developmental disabilities. Age is negatively associated with physical activity and gender is inconsistently associated with physical activity [32]. Memari et al. (2013) found that adolescent girls diagnosed with autism were less physically active compared with boys with autism [43]. However, these findings differed from those of MacDonald et al. (2011) who did not note a difference in physical activity by gender [42]. Notably, certain disabilities, such as autism, demonstrate differences in impairments based on gender, with males being more severely affected. Further, there is a higher prevalence of boys diagnosed with developmental disabilities compared with girls [13]. Future studies exploring the association between gender and physical activity should make an intentional effort to recruit adequate sample sizes of both genders.

Given the impairments often demonstrated by children with developmental disabilities, other individual-level factors are worth exploring. The presence of a disability, in general, may influence children's physical activity in that some studies have found that children with developmental disabilities are less physically active compared with typically developing peers [34, 36, 38, 39, 58]. Further, children with developmental disabilities who present additional comorbidities (e.g., intellectual disability, Attention Deficit Hyperactive Disorder, anxiety) have been found to be significantly less active compared with those without comorbidities [43]. In addition to

the presence of comorbidities, the overall severity of the primary disability may correlate with physical activity, however this remains largely unexplored.

McCoy and colleagues (2016) found that as autism symptom severity increased children were less likely to participate in physical activities. That is, children whose parents classified them as severely impacted by autism were 70% less likely to participate in physical activity compared with typically developing peers [48]. This is consistent with other reports that children with developmental disabilities infrequently engage in sports or other recreational pursuits [59]. It is common for children with developmental disabilities to prefer non-physically active pursuits and lack the motivation for physical activity [60–62]. A study of adolescent males with autism (n = 25, mean age = 14.26 ± 0.89 years) revealed that adolescents were less motivated than typically developing peers (n = 75, mean age = 14.08 ± 0.80 years) to participate in physical education lessons [61]. In addition to the overall severity of the disability, impairments in certain domains, such as social or motor skills may also influence physical activity participation. Many children with developmental disabilities lack the social skills necessary to engage in physically active play with other children [63].

Social impairments are a marked characteristic of certain developmental disabilities, such as Autism Spectrum Disorders. Children with autism have been observed to demonstrate more time in solitary play compared with social play, and those with greater impairments (i.e. more severely affected by autism) engage in even fewer social play activities [64]. Further, young children with autism are less likely to initiate activities with peers [65, 66], thus potentially decreasing opportunities for physically active play. The associations between social impairments and physical activity were

explored in a study of 68 Iranian children and adolescents diagnosed with Autism Spectrum Disorders (ages 6 – 16 years; mean = 9.8 ± 2.0 years) [67]. Participants wore an ActiGraph accelerometer over the right hip for seven consecutive days and parents recorded wear times in a log. Social impairments were assessed using a social skill profile designed for populations with autism. Children with autism who demonstrated a lesser degree of social impairments were more physically active compared with those who were more socially impaired [67].

Motor skill deficits are common among children with developmental disabilities [24] and are perceived as a barrier to physical activity participation by both children and parents [61, 62, 68, 69]. School-aged children (ages 9 – 12 years) with Autism Spectrum Disorders demonstrated significantly poorer motor skills compared with typically developing children who were matched on chronological and mental age [70]. Such deficits may not only hinder children's desire to participate in physically active pursuits, but they could influence physical activity levels. Higher motor skill proficiency has been found to associate with higher levels of typically developing preschoolers' physical activity [71], and most studies in a recent review (n = 8 out of 11 studies) reported a significant relationship between children's motor skills and physical activity [72].

Overall, there is a lack of evidence between many individual-level factors that may associate with physical activity of preschoolers with developmental disabilities. Currently, only age appears to be consistently associated with physical activity levels, however there are few studies from which to draw this conclusion. Other factors, such as gender, weight status, social competence, and severity of impairments have yet to be adequately investigated but could result in a better understanding of the individual-level

factors that influence the physical activity behaviors of preschoolers with developmental disabilities.

Social Environmental Factors

Features of the social environment, such as interactions and engagement from family members, teachers, and peers, have been found to influence young children's physical activity behavior across a variety of settings. Family support for physical activity, determined by parental support and participation in physical activity, is positively associated with young children's physical activity levels [73]. Other adults and peers within different settings can also influence children's physical activity. Teachers' encouragement to be physically active during preschool has been found to increase moderate-to-vigorous physical activity among typically developing preschool-aged children [74]. Nicaise and colleagues (2011) examined how features of the social environment correlated with physical activity levels of preschool-aged children (n = 51) during unstructured outdoor play. Children were 2.1 times more likely to be physically active when solitary compared to when one-on-one with an adult. Further, they were 1.6 times more likely to be active when solitary compared with in a group of peers, although they spent less than 15% of the time in solitary outdoor play [75].

Similarly, the social environment likely influences the physical activity behaviors of children with developmental disabilities [76] and is especially worth exploring among this population given the unique social impairments associated with certain diagnoses. Similar to typically developing peers, certain sizes of social groups may discourage physical activity participation. An exploratory study of age-matched children with (n = 6, mean age = 5.7 ± 0.52 years) and without (n = 6, mean age = 5.3 ± 0.52) autism revealed

that children were significantly more physically active when they were solitary compared to when they were among a group of peers or one-on-one with an adult or peer [76]. In physical activity settings, children with developmental disabilities tend to spend less time engaging with peers compared with typically developing children [77]. When they do engage with others, initiations are often directed towards adults [66, 78], and one study suggests that such interactions with adults may be physical activity promoting.

Pan (2009) explored the physical activity and social behaviors of 25 Taiwanese boys diagnosed with Autism Spectrum Disorders during recess and physical education sessions. Physical activity was objectively measured using accelerometers that were programmed to collect data in 1-minute epochs and social engagement was measured with the Engagement Check, which utilizes a momentary time sampling procedure. Social engagement was categorized as "interactive" (e.g., interdependent play, mutual interactions, gestures) with peers or adults or "noninteractive" (e.g., looking, listening, tracking) with peers or adults. Results indicated that there was a positive relationship between noninteractive engagement with adults and vigorous physical activity during physical education. The authors posit that this may be the result of the teachers paying attention to and providing both verbal and nonverbal support for participation during physical education classes [79], thus creating a positive social environment in which to engage in physical activity.

Social engagement has been observed to improve as children age [65, 79]; however, parents of children (ages 3 – 11 years) with disabilities have reported that their child is often excluded from activities by other children, thus contributing to lower levels of physical activity [80]. Further, lack of teacher or staff training as well as negative

attitudes towards those with disabilities is a common barrier to physical activity participation among this population, thus potentially influencing overall levels of activity [60, 80, 81]. Overall, the literature on social environmental influences of physical activity of children with developmental disabilities is scarce and tends to exclude those of preschool-age. Future research should explore social environmental correlates, particularly among this population.

Physical Environmental Factors

Like the social environment, physical environmental factors (e.g. geographical location, presence of equipment, size of spaces etc.) are associated with young children's physical activity. Evidence suggests that the amount of time typically developing preschool children spend outdoors is associated with increased levels of physical activity [82–84]. Additionally, access to equipment, especially portable play equipment (e.g. balls, hula hoops, scarves), creates a supportive physical activity environment that increases preschool children's physical activity during free play [75, 82, 85–88]. In an observational study, preschoolers were found to be more physically active in areas on the playground with open spaces, fixed equipment, and pathways [86].

Similar to typically developing children, the physical activity behaviors of children with developmental disabilities may vary by physical environment and the time of day in which activity occurs (Capio, Sit, Abernethy, & Masters, 2012; Memari et al., 2013). Memari et al. (2013) found that school-aged (n = 80; mean = 9.6 ± 1.8 years) children diagnosed with Autism Spectrum Disorders were significantly less active in school settings compared with afterschool settings [43]. Further, recess has been found to be more physical activity promoting compared with physical education in the school

setting [89]. Overall, physical activity behaviors among this population appears to be influenced by the structured or unstructured nature of the environment [34, 58]. Unfortunately, children with developmental disabilities have fewer opportunities to participate in structured and unstructured physical activity compared to typically developing peers. As such, limited resources, accessibility issues, and a lack developmentally appropriate programs limit the ability of children with developmental disabilities to engage in health promoting levels of physical activity [60, 62, 80].

Interaction Between Social and Physical Environmental Factors

Features of both the social and physical environment may interact and, in turn, influence young children's physical activity. For example, in the study by Pan (2009), social engagement influenced physical activity behaviors during structured physical education, but not unstructured recess time. In another study, children with Autism Spectrum Disorders interacted more frequently with peers during semi-structured activities compared with during free play [90]. Locke et al. (2016) matched 51 children with autism with 51 typically developing peers on gender, age, grade, class, and ethnicity and found that children with autism spent more time in solitary environments during free play compared with typically developing peers (30% and 9%, respectively) [77]. Similarly, Schenkelberg and colleagues (2015) found that young children (5 – 6 years) diagnosed with autism spent most of free play in solitary environments and were significantly more active while solitary in free play compared with other social group settings. This finding was not observed during structured activity [76].

In a preschool setting, typically developing children were more physically active indoors during teacher arranged activities. Conversely, child-directed activities resulted

in greater levels of physical activity outdoors [82]. Though limited, evidence suggests that factors across ecological levels interact to influence young children's physical activity. Again, such interactions have rarely been explored among preschool children with developmental disabilities.

Measuring Physical Activity in Young Children

Accurate measurement of physical activity behaviors is necessary to identify specific patterns of behavior, track them over time, and determine if intervention efforts are effective. Furthermore, it is important that such measures are valid, reliable, and appropriate for the research being conducted. A variety of methodological approaches are used to quantify children's physical activity, and each methodology presents its own strengths and limitations [91]. Physical activity measurement methodologies can be organized into two categories: subjective and objective measurement. Subjective measures include physical activity recall, interviews, and self- or proxy-report surveys. While subjective measures are certainly valuable in physical activity research, they provide the least compelling evidence of physical activity behaviors especially if the measure has not been validated against more rigorous, objective measure. Objective measures, on the other hand, include measures such as monitoring devices (e.g. pedometers, heart rate monitors, accelerometers), doubly labeled water, and direct observation. Some of these measures are more time- and resource- intensive than others, but they offer the most valid and reliable estimation of children's physical activity.

Objective Physical Activity Measurement in Preschoolers

Young children's physical activity behaviors are sporadic and, unlike older children and adolescents, tend to occur in short bouts [57]. Some objective measures,

such as accelerometry and direct observation, afford a more accurate mode of assessing these bouts of movement during specified time intervals and are considered the most appropriate methodologies for assessing preschool children's physical activity [91, 92].

Measuring Preschoolers' Physical Activity with Accelerometry

Activity monitors, such as accelerometers, are a commonly used objective measurement instrument for assessing physical activity across the lifespan, including preschool populations (Pate, O'Neill, & Mitchell, 2010). These devices provide an objective account of bodily movement and are valuable in both field and laboratory testing. Accelerometers can be programmed to collect data in varying intervals; consequently, they are able to capture the short bursts of movement which are typical of young children [57].

Accelerometers have been validated in typically developing preschool populations with both direct observation and energy expenditure as criterion measures. Overall, they have been found to demonstrate moderate to high validity across physical activity intensities, though validity is device-dependent [92–94]. Other strengths include that accelerometers can provide information on the intensity and duration of physical activity across set periods of times (e.g. school day, afterschool programs, weekdays, weekends) [92]. This allows for easy quantification of meaningful estimates of physical activity, such as percentage of time or minutes per hour, across varying intensities. Further, accelerometers minimize potential bias incurred from self-reported measures of physical activity.

There are, however, several limitations to using accelerometers, particularly among preschool populations. Accelerometers do not distinguish between various types

of movements that are being performed nor do they provide insight into the contextual factors in which activity occurs. Depending on the sensitivity of the device, relevant preschool-aged physical activities, such as quickly riding a tricycle or climbing across monkey bars, may be inaccurately characterized as "light" rather than "moderate-to-vigorous" activity. Next, accelerometers first record activity as "counts" which does not allow for an intuitive interpretation of physical activity patterns. Counts can be converted to more meaningful estimates (e.g. percentage of time, minutes per hour) by applying established cut points, but no consensus has been reached regarding the most appropriate analytic approach, especially for preschool populations [57]. Lastly, purchasing these devices for large scale studies requires substantial financial resources as these devices are costly. Extra devices should be factored in as accelerometers can break or malfunction, resulting in lost data.

Measuring Preschoolers' Physical Activity with Direct Observation

Direct observation is considered among the most appropriate methodologies for assessing young children's physical activity behaviors [91] and it consists of trained observers systematically recording physical activity during specified periods of time. This approach does not rely on child-, parent-, or teacher-recall of information, nor does it rely on external, costly devices. Direct observation minimizes the inferences being made about the types and patterns of physical activity behavior. Unlike accelerometers, this methodology also allows for simultaneous assessment of social and physical environmental contexts in which physical activity occurs. Such contextual information could provide valuable insights into individual- and environmental-level differences in physical activity [57].

In addition to the rich contextual information gathered by observational instruments, there are many additional strengths associated with this methodology. First, direct observation systems allow for the observation of children's natural physical activity behaviors across a variety of settings (e.g., home, school, playground, park). These data can be collected as group- or individual-level data depending on the study design. Observational protocols are flexible in design meaning that, depending on the research question, variable of interest, and setting, researchers can adjust the frequency and duration of observational sessions [95]. Lastly, physical activity codes in many direct observation systems have been validated against measures of energy expenditure and have high levels of reliability [57, 91, 92, 96].

At least six instruments have been used to directly observe physical activity behaviors of preschool-aged children [57]. These include: CARS (Children's Activity Rating Scale) [97], the OSRAC-P (Observational System for Recording Physical Activity – Preschool Version) [98], SCAN-CAT (Studies of Children's Activity and Nutrition-Children's Activity Time-sampling Survey) [99], the BEACHES (Behaviors of Eating and Activity for Children's Health Evaluation System) [100], the CPAF (Children's Physical Activity Form) [101], and the FATS (Fargo Activity Time-sampling Survey) [102]. Three of these instruments, the OSRAC-P, SCAN-CAT, and BEACHES, allow for comprehensive assessment of the types of movement and social and physical environment and only one (OSRAC-P) is specific to the preschool setting.

Some researchers posit that direct observation is an ideal criterion measure to validate other physical activity assessment tools [91, 103], however others argue that a major limitation of direct observation systems is that they are inherently subjective [57]. These

systems do rely on human observers to accurately and consistently record behaviors across different settings. However, clear operational definitions and rigorous observer training sessions can facilitate observer objectivity. Continual monitoring throughout the duration of the study is required to maintain high levels of reliability across observers. Thus, both training and data collection activities are expensive and may not be feasible for large-scale studies. Another major limitation is that direct observation studies are prone to observer and reactivity bias. These can be combatted through random assignment of observers to focal children, blinding observers to the purpose of the study, and familiarizing children with observers by spending time with study participants in the research setting.

Physical Activity Measurement in Children with Developmental Disabilities

Similar to typically developing peers, physical activity behaviors of children with developmental disabilities are often sporadic and occur in brief bouts, typically less than 15 seconds in duration [104]. Physical activity measurement methodologies used with this population vary widely, yet are comparable with those used with typically developing populations [47]. Subjective assessment has been widely used for populations with functional or cognitive limitations. Much of the physical activity literature for children with cerebral palsy is subjective [29, 105, 106]. Self-reported physical activity of children with Down syndrome has been found to be very inaccurate [19] and a recent that these instruments have weak validity in children and youth with developmental disabilities [107]. If subjective assessment has been deemed the most suitable for a study, data should be collected from a variety of individuals who interact with the

participating children (e.g. parents, caregivers, teachers) to more accurately reflect physical activity behaviors [19].

While objective measures tend to provide the most accurate estimations of children's physical activity, measuring the physical activity behaviors of children with developmental disabilities using external devices (e.g. pedometers, accelerometers, heart rate monitors) may be more complex. Participants have been reported to demonstrate sensitivity to external devices and refuse to wear physical activity instruments [47, 108]. Further, some individuals with developmental disabilities exhibit movement limitations, which may present challenges with device positioning [47]. As previously described, individuals diagnosed with cerebral palsy exhibit a wide range of functional abilities. Some children are ambulatory and require no assistance with walking, others are ambulatory but require some assistance with walking in certain settings, and others may require assistive devices such as walkers or wheelchairs. Accelerometers may not accurately characterize device-assisted movement.

Despite potential limitations, accelerometers have also been used among ambulatory populations with developmental and intellectual disabilities [35, 38, 47, 79, 109, 110]. Hinckson and Curtis (2013) found that, of 24 eligible studies, 11 studies utilized accelerometry to assess physical activity behaviors within this population and only one study [36] included preschool-aged children with disabilities. Overall, there appears to be no consensus regarding the validity of accelerometers for use in populations with developmental disabilities [47, 110]. Further, gait patterns, sensitivity to external devices, and adherence to protocol may inhibit the ability of such instruments to detect or accurately estimate physical activity patterns within this population [36, 47, 108, 110].

Some strategies may be taken to improve adherence to accelerometer protocol [111], however other modes of objective measurement, specifically direct observation, may be more ideal for physical activity measurement of young children with developmental disabilities.

Direct observation allows us to explore physical activity behaviors (including intensity and type of movement) while simultaneously assessing contextual factors such as the location in which activity is performed. This is particularly important for children with developmental disabilities. Hinckson and Curtis (2013) found that this is the second most widely used methodology for assessing physical activity of children with disabilities. In their review, six studies measured physical activity using the following direct observation instruments: SOFIT (System for Observing Fitness Instruction Time), SOAL (Scheme for Observing Activity Level), and CARS. In addition to providing contextual information, direct observation reduces the stress induced by wearable tracking monitors and allows for physical activity measurement of subsets of children with developmental disabilities who may be excluded in studies using external monitoring devices (e.g. children with functional impairments or extreme sensitivities to external devices). Several direct observation systems have been used to examine the physical activity behaviors of children with developmental disabilities but few have used these systems with preschool-aged children (Boddy, Downs, Knowles, & Fairclough, 2015; Hinckson & Curtis, 2013; Li et al., 2017; Schenkelberg et al., 2015). Further, no observational systems have been developed that account for unique behavioral and contextual circumstances of physical activity among children with developmental disabilities. Rather than developing a new observational instrument, however, McKenzie

(1991) recommends modifying existing instruments by adding relevant contextual codes to previously validated physical activity codes.

Preschool as a Setting for Physical Activity Intervention

Preschoolers are commonly believed to be highly active; however, a substantial amount of research has found that this is not the case. Most preschool-aged children do not participate in recommended levels of physical activity, including the millions of young children who regularly spend time in the preschool setting. In 2014, over 65% of American preschool-aged children were enrolled in a preschool setting (including Head Start, center-based care, religious and non-religious programs) and the number of children attending center-based care has drastically increased since 2004 [114]. Over 760,000 preschool-aged children in the United States have an identified developmental disability and receive special education services in these preschool settings under the Individuals with Disabilities Education Act (IDEA) [115].

The preschool physical activity environment, both social and physical, is shaped by the various practices and polices implemented at the preschool (Hinkley, Carson, & Hesketh, 2015; Trost, Ward, & Senso, 2010). Studies have found that, among typically developing children, the preschool a child attends accounts for 30-46% of the variance in physical activity [118, 119]. Throughout the preschool day, children are exposed to a variety of behavioral settings (e.g., center time, playground, activity stations) during which physical activity may occur. In typically developing populations, the social and physical environmental features of preschool behavioral settings greatly influence children's physical activity [82]. For example, moderate-to-vigorous physical activity was more likely when the child, rather than the adult, initiated activity on the playground

[82]. Further, young children with disabilities are more physically active in some social group contexts depending on the setting (free play versus structured play) [76].

Certain preschool characteristics, such as the quality of the program and health policies, are associated with typically developing preschoolers' physical activity [87]. Tonge, Jones, and Okely (2016) conducted a systematic review to explore correlates of the preschool environment with physical activity behaviors. Twenty-seven studies met the inclusion criteria and quantified physical activity using objective measures (accelerometers, pedometers, and direct observation). Overall, features of preschools' physical environment were strongly associated with preschool children's physical activity behaviors [120]. That is, specific characteristics of the physical environment such as the size, use, and presence of outdoor and open play spaces was associated with higher levels of physical activity. Some studies found that preschoolers' physical activity was influenced by teachers' prompts for physical activity [87, 121, 122]. However, other features of the social environment (e.g. social group contexts) were not strongly associated (less than 60% of studies reported consistent associations) with preschoolers' physical activity [120]. Undoubtedly, there is extensive evidence that preschools are important settings for physical activity and that features of the preschool environment can influence typically developing children's physical activity. Whether these findings hold true for those with developmental disabilities has yet to be determined. Physical activity of children with developmental disabilities is vastly underexamined and little is known about how features of preschool environments associate with physical activity behaviors.

Summary

Empirical evidence demonstrates that higher levels of physical activity during the preschool years has a protective effect on health outcomes as children grow and develop [2, 123–125]. Therefore, creating opportunities and supporting physical activity during early childhood may result in immediate and long-term health and developmental benefits for children with developmental disabilities [126].

Young children spend a considerable amount of time in preschools, a setting that is accessible to those with and without developmental disabilities. Preschools provide numerous opportunities for participating in physical activity and are an ideal setting for examining physical activity behaviors and influences among children with developmental disabilities. To support children's educational and developmental goals (e.g., improvements in daily living skills, communication, and social skills), preschools that serve children with developmental disabilities may integrate various therapeutic and other programming opportunities into the daily routine. Such opportunities may be unique to special education preschool classrooms and provide additional social and physical environmental contexts during which physical activity may occur (e.g., one-on-one instruction with a paraeducator during pre-academic lessons, segregated occupational or speech therapy sessions, social skills lessons).

Directly observing physical activity patterns of children with developmental disabilities within the various special education preschool contexts can reveal potential physical activity intervention opportunities. This project aims to develop an observational instrument that considers contextual circumstances that are unique to special education preschool classrooms and will aid in researchers' understanding of

physical activity behaviors of preschoolers with developmental disabilities and how features of the preschool environment influence such behaviors. The preschool setting has already proven to be a valuable and successful setting to observe and implement physical activity interventions among typically developing children and while this may hold true for those with developmental disabilities, there is a critical need for more research.

Study One Methods

Purpose

The purpose of this study is to develop an observational instrument for the preschool setting that will allow for the systematic observation of the physical activity behaviors and contexts of preschool children with developmental disabilities.

There is currently no physical activity observational system specifically designed for use in populations of children with disabilities; however, many observational systems exist for typically developing children. One instrument, the Observational System for Recording Physical Activity in Children – Preschool (OSRAC-P), is a momentary time sampling system which allows for the collection of three different types of information during the preschool day: 1) the type and intensity of the focal child's physical activity, 2) the physical environment (e.g. indoor or outdoor locations, educational contexts, and play contexts), and 3) the social environment (i.e. group composition, the initiator of the activity, and prompts for physical activity). Physical activity intensity codes have been previously validated for preschool-aged children [97] and the instrument has been widely used among typically developing populations. Recent exploratory studies that utilized the OSRAC-P to measure physical activity and sedentary behavior of children with Autism

Spectrum Disorder (ASD) found that this instrument lacks appropriate codes to sufficiently capture the movement types and social environment experiences that are unique to this population [76, 127].

The OSRAC-P can serve as a model for the development of a new instrument, which will be referred to as the Observational System for Recording Physical Activity in Children – Inclusive (OSRAC-I) version. A new instrument will be useful for describing physical activity behaviors and the contexts in which they occur during the preschool day, and for informing future interventions for young children with developmental disabilities.

Aim 1: Develop a reliable observational instrument to measure physical activity behaviors of preschoolers with developmental disabilities as well as the contextual circumstances during which physical activity occurs during the preschool day.

Objective 1a: To establish reliability of the new physical activity observational instrument.

Study Design

An exploratory cross-sectional study will be conducted to determine the appropriate observational categories and accompanying codes for the new instrument and to assess reliability.

Methods

The present study will result in the development of a new physical activity observation instrument, the OSRAC-I, for use in inclusive preschool environments to assess the physical activity levels of preschoolers with developmental disabilities. Additionally, the OSRAC-I will allow for simultaneous assessment of the social and

physical environment during the preschool day, resulting in identification of the contextual circumstances during which physical activity occurs. An existing observation instrument, the OSRAC-P, is comprised of eight observational categories and accompanying codes, which allow for the recording of physical activity intensity, type, location, and environmental contexts during the preschool day; however, some categories and codes should be revised and redefined to be more suitable for observations of preschoolers with developmental disabilities. Thus, the OSRAC-P will serve as a guide in the eight-step development process of the OSRAC-I.

Step 1

Various instruments have been developed over the past several decades to directly observe and measure children's physical activity behaviors. The first step in the present study is to review the literature to identify existing physical activity observational instruments used among preschoolers with and without developmental disabilities. Instruments will be reviewed to determine validity, reliability, observational categories and codes, measurement protocol, and utility for populations with developmental disabilities. Then, informal review of specific physical activity types and patterns of preschoolers with developmental disabilities will be conducted to identify unique movement codes (e.g. toe-walking, rocking, hand flapping, "stimming") that should be considered for inclusion in the new instrument. Lastly, observational instruments used to assess social engagement and interaction of young children with developmental disabilities will be reviewed to inform the social environment categories of the OSRAC-I.

Step 2

The second step will be focused on ensuring content validity of the new instrument. Informal observations will be conducted in inclusive and segregated preschool classrooms in order to identify unique behavior settings (e.g. speech, physical, or occupational therapy), movement types, and social circumstances (e.g., interaction with therapists or paraprofessionals) experienced by children with developmental disabilities during preschool. Then, experts in the fields of Early Childhood Education, Psychology, and Special Education will be contacted for consultation. Experts will first review the existing OSRAC-P observational categories and definitions and will determine each category's suitability for preschoolers with developmental disabilities. Then, they will identify and provide justification for observational categories and codes that should be removed from or included in the new instrument. Lastly, experts will assist with operationally defining the observation categories and codes that they recommend be added to the OSRAC-I.

Step 3

The third step in the OSRAC-I development is to make decisions about whether to retain or remove existing OSRAC-P observation categories and codes. These decisions will be informed by the literature reviews, informal observations, and expert feedback. Justification for each item retained or removed will be provided. Additionally, operational definitions of observation categories will be revised as needed.

Step 4

The fourth step is to identify observation categories and codes, which differ from those of the OSRAC-P, which should be included in the new instrument. Again, decisions

will be informed by the literature reviews, informal observations, and expert feedback. New observation categories and accompanying codes will be operationally defined.

Step 5

During the fifth step, the OSRAC-I instrument and observation protocol will be developed. Observation categories and codes retained from the OSRAC-P as well as those, which were newly developed will be organized using the MOOSES/LILY program, a software system for observational data collection. The program organizes content on a single screen with a list of observational categories. Upon selection of an observational category, codes applicable to the selected category appear and the user can then select the appropriate code for that category. Additionally, the observation categories, codes, and time-sampling intervals will be customized in the program according to the OSRAC-I observation protocol.

The OSRAC-I observation protocol will utilize a focal child, momentary time-sampling procedure and will parallel the OSRAC-P protocol. Twenty-minute observation sessions will be comprised of 30-second coding intervals. Each coding interval consists of a 5-second observation interval followed by a 25-second recording interval. The 5-second observe, 25-second record intervals will repeat continuously during the 20-minute observation session, yielding a total of 40 coding intervals per session. During observation sessions, data will be entered into the MOOSES/LILY program using handheld devices.

Step 6

After the development of OSRAC-I, research assistants will be trained through a series of observer training sessions. First, research assistants will participate in an

orientation session during which they will become familiarized with: 1) children with developmental disabilities, 2) physical activity behaviors of young children, and 3) direct observation of physical activity. At the end of the orientation session, research assistants will be provided with the OSRAC-I training manual which will consist of observation protocols, observation categories and corresponding codes, and operational definitions. Research assistants will memorize contents of the training manual prior to the next observer training session, during which they will complete a series of quizzes to assess their understanding. After memorizing observation protocols, categories, and codes, research assistants will view and practice training videos. These videos will consist of pre-recorded preschool physical activities during indoor and outdoor contexts. Research assistants will independently code the video segments using the OSRAC-I and inter-observer agreement will be assessed. Upon completing practice observation sessions, research assistants will compare results and participate in group discussion, during which they will have opportunities to ask questions and receive feedback. Next, research assistants will practice using the OSRAC-I in an inclusive preschool classroom. Observation practice will include observation sessions conducted in pairs in order to allow for discussion between observers, and then independently with no discussion between observers. Inter-observer agreement during independently-coded practice sessions will be calculated and at least 80% agreement in all categories will be required before proceeding with field testing the OSRAC-I.

Step 7

Following observer training, reliability of the newly developed OSRAC-I will be established during field testing in inclusive and segregated classrooms. Pairs of research

assistants will simultaneously, but independently code the same focal child during an observation session. Inter-observer agreement will be calculated for each session and observational category using Cohen's kappa and percent agreement. Percent agreement will be determined using the following equation: [#agreements/(#agreements + #disagreements)] x 100.

Step 8

After field-based observations, the research team will convene to discuss the OSRAC-I and its observational categories and codes. The team will determine whether the OSRAC-I observation categories appropriately captured the various behavioral, instructional, and environmental contexts found within inclusive and segregated preschool classrooms. If additional observational categories are needed, the research team will modify the OSRAC-I and will repeat Step 7 to re-establish reliability.

Participants

In an effort to observe a variety of behaviors and preschool contextual circumstances, a convenience sample of eighteen preschool children with developmental disabilities from inclusive and segregated preschools (n = 3) will be recruited from the Columbia, South Carolina or surrounding areas to participate in Phase 1, the OSRAC-I reliability study. To be included in the study, children must be 1) 3 – 5 years old, 2) diagnosed with autism, developmental delay, or intellectual disability by a doctor or other health care professional, and 3) ambulatory with no medical concerns or physical conditions that could impair independent movement.

Measures

Demographic Survey

Parents or caregivers of participating children will complete a brief demographic survey after returning the consent form. The demographic survey will query parents/caregivers on the age, gender, and diagnosis of the participating child. Parents will receive a $25 gift card upon returning the survey as a thank you for their time and effort.

Observational System for Recording Activity in Children – Inclusive Version

Reliability for the newly developed physical activity observational instrument, the OSRAC-I, will be established in the present study. The OSRAC-I will be comprised of observation categories and accompanying codes to assess physical activity of preschoolers with developmental disabilities and the contexts in which physical activity occurs. Observation categories will include some categories from the OSRAC-P as well as others which were specifically developed to assess contextual circumstances in inclusive and segregated preschool classrooms as well as unique movements demonstrated by some children with developmental disabilities. For example, the OSRAC-I will include other types of physical activities that are characteristic of preschool children with developmental disabilities and not typically developing peers (i.e. toe-walking, hand stimming, flapping, etc.). Additionally, the new observational instrument will delve deeper into aspects of the social environment which are especially relevant to children with developmental disabilities. Specifically, “interaction” and “engagement” codes will be better defined and will be drawn from existing engagement

observational systems in order to better capture true social interaction and engagement with peers and adults across behavior settings.

Data collection protocol for the OSRAC-I will mirror that of the OSRAC-P in that it will remain a focal child, momentary time sampling observation system. Individual observation sessions will consist of two, 5-second observe and 25-second record coding intervals per child (two coding intervals per minute comprises one observation session). Observation sessions will be repeated for 20 minutes, resulting in a sample of 40 coding intervals per session.

Procedures

OSRAC-I Training Procedures

Research assistants will be recruited from the undergraduate and graduate Exercise Science and Public Health programs at the University of South Carolina and will be trained on the OSRAC-I using the same protocol as that of the OSRAC-P. As previously described, training will consist of an orientation meeting, code memorization, demonstration of understanding through various quizzes, video coding, and field-based observations.

First, research assistants will attend an initial orientation meeting during which they will receive relevant, published manuscripts on topics including: observational physical activity measurement, physical activity and children with developmental disabilities, and physical activity behaviors of preschoolers. Additionally, research assistants will receive a training manual that will consist of operational definitions of OSRAC-I codes, observation protocol, and decisional prompt trees. Research assistants will be instructed to read the manuscripts and memorize the codes and operational

definitions. At each meeting, research assistants will complete a quiz to assess comprehension of each of the observational categories and they will have an opportunity to ask questions and discuss the codes, definitions, and protocols. Before proceeding to the next round of training, each research assistant must achieve 100% accuracy on quizzes to ensure understanding of all codes and definitions.

Next, research assistants will view videos of preschool children performing physical activity during the preschool day. A focal child will be assigned to the research assistants who will then simultaneously, but independently, record observations using the OSRAC-I following the 5-second observe, 25-second record protocol for 20 minutes. Data will then be compared to determine inter-observer agreement. Once a criterion of at least 80% interval-by-interval agreement has been achieved, field-based observation sessions will begin. These sessions aim to familiarize research assistants with conducting observations in a real-world preschool setting and to ensure continuing high levels of inter-observer agreement for each category. The number of practice observation sessions is dependent on research assistants' achievement of acceptable levels of agreement.

OSRAC-I Reliability Study (Phase 1)

After obtaining parent/caregiver consent, trained research assistants will visit the preschool classrooms to conduct Phase 1 observations. Weekly schedules will be obtained from the preschool teachers in order to schedule observation sessions. Research assistants will be randomly assigned a focal child to observe using the 5-second observe and 25-second record protocol for each 20-minute observation session. Each child participating in the Phase 1 of the study (n = 18) will be observed 8 times, excluding nap times, yielding a total of 320 coding intervals per child and a total of 5,760 coding

intervals for the whole sample. At the end of each observation session, research assistants will note any additional physical activity types or contextual circumstances that they observed which are not included in the OSRAC-I. During data collection, inter-observer agreement assessments will be conducted during 20% of the observation sessions across different times of the day and settings, and for different children and observers. Two observers will independently code the same focal child in the same observation session while listening to an audio prompt through split headphones.

Analysis

To assess reliability of the OSRAC-I, inter-observer agreement will be calculated on an interval-by-interval level basis for 20% of the observations sessions (n = 29) using the following equation: [#agreements/(#agreements + #disagreements)] x 100. To consider inter-rater agreement that may occur by chance, Cohen's kappa will also be calculated.

Confidentiality and Ethics

Preschool teachers will provide verbal consent to allow the research group to conduct observations in their classroom. Written informed consent will be obtained from parents or caregivers of participating children. After receiving a completed consent form, children will receive a unique identification number in order to maintain confidentiality. All data that can be linked back to participants' names will be locked in a secure location.

Study Two Methods

Purpose

The purpose of this study is to describe the physical activity behaviors of preschoolers with developmental disabilities during the preschool day. Preschoolers are

commonly believed to be highly active; however, a substantial amount of research has found that this is not the case. Most preschool-aged children do not participate in the recommended levels of daily physical activity (15 minutes per waking hour), including millions of young children who regularly spend time in the preschool setting. A sub-group of children in preschool settings are those with diagnosed developmental disabilities.

Over 760,000 preschool-aged children in the United States have a diagnosed developmental disability and receive special education services. In South Carolina, 9,432 children with developmental disabilities (ages 3 – 5 years) are receiving preschool special education services through Individualized Education Plans (IEPs). Of these children, 57% and 25% are receiving special education services in a regular or segregated preschool classroom, respectively. The preschool setting is an ideal setting to intervene upon the physical activity behaviors of young children with developmental disabilities, however little is known about the physical activity behaviors of this population during the preschool day.

Aim 2: Describe the physical activity behaviors of preschoolers with developmental disabilities in the preschool setting.

> **Objective 2a**: To describe the time (minutes per hour and percentage of time) preschoolers with developmental disabilities spend in total physical activity (light, moderate, and vigorous intensities) and moderate-to-vigorous physical activity during the preschool day.

Objective 2b: To describe the influences of individual-level characteristics (e.g. age, gender, diagnosis) of preschoolers with developmental disabilities on total physical activity and moderate-to-vigorous physical activity.

Study Design

A cross-sectional study design will be utilized to describe the study population and their typical levels of physical activity during the preschool day.

Methods

Participants

During the fall of 2017, 35 preschoolers with developmental disabilities in and around Columbia, South Carolina will be recruited to participate in the study. Demographic characteristics of eligible participants from local school districts are presented in Table 6.1. The most prevalent developmental disabilities in South Carolina include speech-language impairment (47%), developmental delay (37%), and autism (11%). It is not unusual for typically developing children to be diagnosed with speech-language impairment early in life; therefore, children diagnosed with only a speech-language impairment will be excluded from the study. To be eligible for participation in the study, preschoolers must be: 1) 3 – 5 years old, 2) diagnosed with autism, developmental delay, or intellectual disability by a doctor or other health care professional, 3) receive special education services, and 4) be ambulatory and without medical conditions that could impair independent movement.

Measures

Demographic Survey

After consenting to the study, parents or caregivers of participating children will provide demographic information by completing a parent survey. Parents will report the child's age and birthday, sex, race/ethnicity, diagnosis, socioeconomic status (determined by income and parent's highest level of completed education), and other details regarding the participant's developmental health, early intervention, and educational needs (e.g., physical therapy, speech therapy, IEP).

Vineland-3 Adaptive Behavior Scale

Individuals with developmental disabilities often demonstrate impairments in adaptive behaviors that "refers to the skills needed by individuals to function and be self-sufficient within their everyday environments" (Sparrow et al., 2005). Various instruments have been developed to measure children's adaptive behaviors, including the Vineland Adaptive Behavior Scales. The Vineland is a norm-based scale that is used in clinical practice to classify functioning of children and adults (birth - 90years) with developmental disabilities across several key domains: communication, daily living skills, socialization, motor skills, and adaptive behavior. It has been instrumental in confirming or establishing diagnoses (e.g., intellectual disability, Autism Spectrum Disorder), assisting with school-based IDEA evaluations, program planning, and research. In the present study, the third version of the Vineland, Vineland-3, will be utilized to characterize impairments of the study population. This version has been updated to reflect changes in daily living and conceptions of developmental disabilities.

Further, outdated items have been removed or modified and the items, in general, account for potential cultural differences.

Vineland-3 Training

The Vineland-II and Vineland-3 were designed to be clinical instruments used by individuals with graduate-level training in psychology or social work. However, professionally trained individuals from other disciplines who have received formal academic training and have had supervised experience with the instrument may also be qualified to administer the Vineland (Sparrow et al., 2005, p. iv). In the present study, a doctoral student in Exercise Science who has completed coursework in child and human development, special education, and psychoeducational assessments will be trained by researchers in the Neurodevelopmental Disorders Laboratory in the Department of Psychology at the University of South Carolina. Standardized Vineland training protocol used to train researchers within the lab will be followed to ensure reliability. Training will be completed in four steps: 1) read the Vineland Manual, 2) attend in-lab trainings, 3) co-scoring audio recordings of three Vineland administrations with at least one scored assessment achieving at least 80% reliability with a "gold standard" trainer, and 4) two Vineland administrations, one administration must be for a child with developmental delay, and achieving 80% reliability on both administrations. During the final step, the trainee will audio record her Vineland administrations and will turn the recordings in to the Vineland trainer in the Neurodevelopmental Disorders Lab. The trainer will score the recordings and reliability will be assessed using the following equation: [(total number of agreements/total number of items administered) x 100].

Vineland-3 Administration Protocol

After achieving acceptable levels of reliability (≥80%), the trained researcher will administer the Vineland-3 to parents or caregivers through semi-structured interviews. The interview administration format is the recommended method of delivery as it allows for parent or caregivers to provide an in-depth account of their child's level of functioning through the report of daily activities and behaviors. The open-ended nature of the interviews allows the interviewer to probe for more information and true frequency of skills and behaviors as well as determine whether these activities are performed independently. Lastly, the interview format results in more consistent scoring since the interviewer is recording responses and allows for the emphasis of what the child *does do* rather than what the child *can do*.

Throughout the course of the study, the trained Vineland administrator will call parents or caregivers at a time that is most convenient for them, as reported in the parent survey. The interview will begin with the administrator asking parents to confirm the school, diagnosis, and birth date of the child and to provide a mailing address if they wish for their compensation to be mailed. Then, the administrator will read a pre-determined script about the Vineland assessment. This script will emphasize to the parents that there is no "right" or "wrong" answer, they should describe what their child *does do* rather than what s/he *can do*, the responses are kept confidential, and that not all individuals perform the same activities at the same age. After the script is read to the parents, they will have an opportunity to ask questions.

The Vineland-3 consists of 502 items that are organized into five domains and accompanying subdomains (Communication: Receptive, Expressive, Written; Daily

Living Skills: Personal, Domestic, Community; Socialization: Interpersonal Relationships, Play and Leisure, Coping Skills; Motor Skills: Fine, Gross; Maladaptive Behavior: Internalizing, Externalizing). The administrator will use a unique record booklet for each interview. In this booklet, the 502 items are presented in order from the easiest to the most difficult by subdomain, and the chronological age at which the items tend to emerge are indicated on the scoring form. The administrator locates the starting point based on the child's chronological age and begins the open-ended interview. Based on the parent's response, the administrator will record the following codes for each skill: usually demonstrates the skill, "2", sometimes demonstrates the skill, "1", and never demonstrates the skill, "0". The interview will continue until a "basal" (four consecutive items marked as "2") and "ceiling" (four consecutive items marked as "0") is established. Each child's Vineland-3 will be entered into the Q-global software where it will be scored and child-level reports will be generated. The Vineland-3 will provide a thorough description of the degree of impairments among participants in the present study and will allow for the exploration of domain-specific impairments on physical activity behaviors.

Accelerometry

Daily physical activity during preschool will be assessed using accelerometry. An accelerometer will be attached to an elastic belt and worn over the right hip for the duration of the preschool day. Accelerometers have been widely used among preschool populations and have also been used in populations with developmental disabilities. The accelerometers will be programmed to record data in 15 second intervals in order to capture the spontaneous nature of young children's physical activity patterns and validated cut-points [93] will be applied to determine the time spent in the various levels

of physical activity intensity throughout the preschool day. To date, validated cut-points for preschool children with autism or developmental delay have not yet been established; however, the cut-points that will be used in the present study have been used to estimate physical activity of preschool-aged children with autism [50].

Procedures

Preschool teachers from participating classrooms will be asked to provide the research team with a copy of the classroom's typical schedule (e.g., start and end times, meal times). Research assistants will distribute parent information packets, which will include the consent form and demographic survey, to participating preschool teachers who will then send the packets home with the children in their classroom. Parents will be asked to return the consent form and survey to their child's teacher and will indicate their preferred days and times for completing the Vineland-3 interview. Research assistants will screen the demographic data and will exclude children without requisite diagnoses.

Participating children will wear an accelerometer for five consecutive days during preschool for at least 3 hours per day, in order to account for children attending half-day preschool programs. Upon arriving to preschool, a research assistant will attach the accelerometer to each participating child. To help increase compliance, research assistants will recite a brief "social story" to child as the accelerometer is being attached [66,50]. Monitors will be removed at the end of the day by the research assistant and wear time (start and end times) will be recorded by research assistants in a log.

Analyses

Accelerometry-derived physical activity will be determined by applying validated cut-points to determine the average time spent in sedentary (0-799 counts per minute), light (800-1679 counts per minute), moderate (1680-3367 counts per minute), and vigorous (≥3368 counts per minute) physical activity [93]. Accelerometers will be worn for the duration of the preschool day, and only data from children who wore the accelerometer for ≥50% of the preschool day for ≥3 days per week will be included in the analyses [129].

Using the Vineland-3 data, an Adaptive Behavior Composite (ABC) score will be calculated for each child. The ABC is based on scores reported in the Communication, Daily Living Skills, and Socialization domains and can be compared with age-specific normative mean scores. Vineland-3 qualitative descriptors will identify children with moderately low to low ABC scores (ABC scores of ≤85) as "more impaired" and children with adequate to typical levels of adaptive behavior (ABC scores of ≥86) as "less impaired". The differences in accelerometer-derived physical activity (MVPA and TPA) between children in the "more impaired" and "less impaired" groups with autism and children with developmental delay/intellectual disability will be assessed using mixed linear regression models which will include age, gender, race, parent education level, and accelerometer wear-time (hours/day) as covariates. Classroom will be included as a random effect to account for correlations between children in the same preschool class.

Additional mixed linear regression models will be used to explore how physical activity of the full sample (MVPA and TPA) is influenced by intrapersonal characteristics including: age, gender, race, and adaptive behavior (average adaptive behavior score across all domains). The influences of domain-specific adaptive behaviors (e.g.,

communication, socialization, motor skills) will be further explored if overall adaptive behavior is found to be significant predictors of physical activity in the models.

Confidentiality and Ethics

Preschool teachers will provide verbal consent to allow the research group to conduct observations in their classroom. Written informed consent will be obtained from parents or caregivers of participating children and verbal assent will be obtained from parents before completing the Vineland-3 form. After receiving a completed consent form, children will receive a unique identification number to maintain confidentiality. This identification number will be used on the demographic survey, accelerometer logs, and Vineland-3 Scale forms. All data that can be linked back to participants' names will be locked in a secure location.

Study Three Methods

Purpose

The purpose of this study is to identify how features of the social and physical environment in the preschool setting influence the physical activity behaviors of preschoolers with developmental disabilities. Throughout the preschool day, children are exposed to a variety of behavioral settings (e.g. center time, playground, activity stations) during which physical activity may occur. In typically developing populations, the social (e.g., peer, family, teacher interactions, prompts, social group contexts) and physical (e.g., geographical location, presence or absence of equipment, features of the built environment) environmental features of the preschool behavioral settings greatly influence physical activity. For example, moderate-to-vigorous physical activity is more likely when the child initiates activities on the playground compared to when the adult

initiates the activity [82]. Although numerous studies have investigated how characteristics of the preschool setting influence physical activity of typically developing children, they have yet to consider the influences of such features on the behaviors of children with developmental disabilities.

Aim 3: Identify associations between the physical activity behaviors of preschoolers with developmental disabilities and features of the social and physical environment within the preschool setting.

Study Design

A cross-sectional study design will be utilized to describe the social and physical environmental factors in preschools that influence typical physical activity behaviors of the study population.

Methods

Participants

Participants in the present study will be the same as Study 2. Thirty-five preschoolers diagnosed with developmental delay or autism will be recruited from local preschools in an around the Columbia, South Carolina area. To be eligible for participation in the study, preschoolers must be: 1) 3 – 5 years old, 2) diagnosed with autism, developmental delay, or intellectual disability by a doctor or other health care professional, 3) receive special education services, and 4) be ambulatory and without medical conditions that could impair independent movement. Parents or caregivers will provide informed consent before their child can participate in the study.

Measures

Demographic Survey & Vineland Adaptive Behavior Scale

As in Study 2, a parent survey will be completed and will provide necessary demographic information such as age, sex, race/ethnicity, diagnosis, and developmental health, early intervention, and educational needs of their child. Parents will also complete the Vineland-3 Adaptive Behavior Scale as a semi-structured interview with a trained Vineland administrator to provide a profile of their child's impairments in communication, daily living skills, socialization, motor skills, and adaptive behavior.

Physical Activity

The Observational System for Recording Physical Activity – Inclusive version (OSRAC-I) will be utilized to assess preschool children's physical activity behaviors. OSRAC-I measurement protocol will be similar to that of the Observational System for Recording Physical Activity – Preschool version (OSRAC-P). Trained research assistants will observe child-level physical activity behaviors and environmental contexts in which physical activity occurs. Physical activity data includes the level, or intensity, at which physical activity is performed as well as the various types of movement (e.g., walking, running, skipping). Physical activity intensity will be recorded on a scale of 1 through 5 and will be aggregated into the following intensity levels: sedentary (codes 1 and 2), light (code 3), moderate (code 4), vigorous (code 5), total physical activity (TPA; codes 3, 4, and 5), and moderate-to-vigorous physical activity (MVPA; codes 4 and 5). Data will be recorded using handheld devices programed with the MOOSES/LILY observation software and observation responses and codes will be organized by behavioral category (e.g., physical activity level, physical activity type, indoor contexts, outdoor contexts, social environment).

Physical and Social Environment

During OSRAC-I observation sessions, research assistants will simultaneously record physical activity behaviors and the physical and social environmental contexts during which physical activity occurs. Physical environment observation categories will provide information on: location (indoors, outdoors, transition), indoor educational or play contexts (e.g., art, preacademic, group time, snacks, self-care), and outdoor educational or play contexts (e.g., fixed equipment, ball, games, teacher-arranged activities). The social environment observation categories will provide information on: the initiator of activity (adult or child), group composition (e.g., solitary, one-on-one with an adult, group of peers), engagement (e.g., child is actively engaged, child is passively engaged), and prompt for physical activity (e.g., teacher prompts child to increase activity).

Procedures

Prior to data collection, preschool teachers from participating classrooms will be asked to provide the research team with a copy of the classroom's typical daily schedule (e.g., start and end times, nap times, meal times). Research assistants will distribute parent information packets, which will include the consent form and demographic survey, to participating preschool teachers who will then send the packets home with the children in their classroom. Parents will be asked to return the consent form and survey to their child's teacher and will indicate their preferred days and times for completing the Vineland-3 interview. Research assistants will screen the demographic data and will exclude children without the requisite diagnoses.

An observation schedule will be developed by the research assistants before beginning observations. Each child (n = 35) will be observed 6 times by trained research assistants over the course of the study in order to capture a variety of preschool physical activity contexts. Observation sessions for each child will be randomly assigned to a research assistant and time slot before data collection to capture the various preschool contexts to which they are exposed. Nap times and meal times (except for snack) will be excluded from observations. Observation sessions will be 20 minutes in duration and are comprised of 30-second coding intervals. Each 30-second coding interval consists of a 5-second observation followed by a 25-second recording interval and repeat continuously across observation sessions (two coding intervals per minute). A total of 240 coding intervals will be conducted per child, yielding a total of 8,400 coding intervals across the entire sample. Inter-observer reliability estimates will be conducted for at least 10% of the observation sessions (n = approximately 21 sessions). Two research assistants will simultaneously but independently record the same focal child's physical activity behaviors and contextual information to determine interval-by-interval level agreement across all categories.

Analysis

Percent agreement and Cohen's kappa will be determined for each category to assess inter-rater reliability. Descriptive statistics will be calculated to determine the number and percentage of intervals spent in moderate-to-vigorous physical activity (MVPA) and total physical activity (TPA; includes light, moderate, and vigorous levels). Adaptive Behavior Composite (ABC) scores will be calculated and, using Vineland-3 qualitative descriptors, children will be grouped into two categories: "more impaired" and

"less impaired". Pearson's chi-square analyses will evaluate differences in gender, adaptive behavior ("more impaired", "less impaired"), and age (younger, ≤4 years; older, >4 years) by directly observed physical activity intensity level (MVPA, TPA).

The number and percentage of intervals spent in MVPA and TPA across social and physical environmental contexts will be calculated. Then, two logistic regression analyses will be performed with intervals as the unit of analysis, and binary intensity level (MVPA and non-MVPA; TPA and non-TPA) as the dependent variable. Models will be adjusted for age (younger, older), gender, and adaptive behavior ("more impaired, "less impaired"), and the most frequently occurring contextual conditions of the physical environment (activity context, location) and social environment (initiator, group composition, engagement, interaction) will be inputted into the model.

Confidentiality and Ethics

Preschool teachers will provide verbal consent to allow the research group to conduct observations in their classroom. Written informed consent will be obtained from parents or caregivers of participating children and verbal assent will be obtained from parents before completing the Vineland-3 form. After receiving a completed consent form, children will receive a unique identification number to maintain confidentiality. This identification number will be used on the demographic survey, OSRAC-I observation forms, and Vineland-3 forms. All data that can be linked back to participants' names will be locked in a secure location.

Table 6.1. Demographic characteristics of preschool-aged children diagnosed with autism or developmental delay in South Carolina (by school district)

	Richland I	Richland II	Lexington I	Lexington II
n	263	289	292	147
% Male	70.7	69.8	75	73.5
3 years	56	50	51	36
4 years	81	86	108	42
5 years	126	153	128	69
Black/African American	208	153	30	39
Hispanic/Latino	*	33	22	37
White	35	78	215	62

*indicates fewer than 10 children

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