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Research Article

Increasing Physical Activity in Youth with Autism and Other Developmental Disabilities in Physical Education

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ABSTRACT

Youth with Developmental Disabilities (DD) are less active and more sedentary than their typically developing peers.The purpose of this study was to investigate differences in time spent sedentary and in moderate-to-vigorous physical activity (MVPA) in youth with DD during Physical Education (PE) versus the Fitness Fun zone (FFZ)®. Twenty-three children (8-17 years) were observed during PE and FFZ on 20 non-consecutive days. Physical activity levels were measured by accelerometers. Repeated measures mixed effects models were used to estimate time spent sedentary and in MVPA during PE versus FFZ. The FFZ led to a greater percent of time spent in MVPA (+19.9, 95%CI: 17.6, 21.5) and less percent of time sedentary (-13.4, 95%CI:-14.9, -11.9) compared to PE. The FFZ is a feasible curriculum that can increase health-enhancing physical activity levels and reduce time spent sedentary for youth with DD.

INTRODUCTION

Developmental disabilities (DD) in youth involve impairments in cognitive, physical, behavioral, and adaptive functioning [1] (CDC; Centers for Disease Control and Prevention, 2015) and covers disorders such as Intellectual Disabilities (ID) and learning disabilities, Autism Spectrum Disorders (ASD), Attention Deficit Hyperactivity Disorder (ADHD), Cerebral Palsy (CP), and other disorders that affect independent functioning [1] (CDC, 2015). The number and degree of symptoms vary across individuals, but characteristics of those with DD include deficits in psychosocial functioning (e.g: social and communication skills), motor skills, and restricted or stereotyped patterns of activities, interests, or behaviors (e.g: hand flapping, repetitive behavior; APA, 2013). Additionally, youth with DD are at risk for being more obese and less physically active then their Typically Developing (TD) peers [2-5], which can lead to chronic health concerns including diabetes, high cholesterol, asthma, high blood pressure, social isolation, sleep difficulties, as well as other psychological problems [6].

Physical Activity (PA) benefits children with DD by increasing physiological well-being, prosocial behaviors, communication, emotional regulation, academic achievement, overall quality of life, and reducing stereotypic behaviors [7-12]. Further, participation in PA during childhood and into adolescence is related to PA throughout

the life span. Despite these findings, studies concerning PA or on strategies to increase PA within this population are limited, have mainly focused on one specific group of disabilities (e.g: ASD, ID or ADHD), have utilized subjective reports of PA versus observational and objective measures, and contain other methodological issues [7].

Physical Education (PE) is a promising setting for increasing children and adolescents' PA because it is regularly scheduled during school and reaches a large amount of children [13]. Several organizations have recommended that children should engage in MVPA for 50% of the time during PE, however, many children and adolescents fail to achieve these guidelines [14-20]. It is even more challenging to achieve these guidelines with youth with DD as they are overall less physically active than their TD peers, they have deficits in motor skills, following directions, and paying attention [21-23]. Therefore, it is imperative that PE teachers maximize the amount of MVPA children and adolescents with DD accumulate during PE and develop modifications to already developed programs to accommodate the unique needs of youth with DD [24-28].

Techniques that have been suggested to increase PA in youth with DD include providing physical layouts (e.g: clear boundaries), visual schedules and cues (e.g: visually depicted materials related to PA), simple directions, and positive behaviors from staff (e.g., verbal encouragement; [29,30]). A newly developed program, the Fitness Fun Zone® (FFZ), is a structured and visually based activity station program for youth to help increase PA in a variety of settings (e.g. PE, recess) through incorporating these techniques. Activity stations are adaptable and easily modifiable forms of exercise that consists of rotating through several different stations with rests in between. Previous research has indicated that these stations have the potential to promote MVPA and overall mental health for children with DD and other disabilities during PA opportunities [31-37].

The current study is the first to investigate the effectiveness of the FFZ in comparison to traditional PE within a school for youth with DD including ASD, ADHD, learning disabilities, and other DD. The purpose of this study is to investigate differences between traditional PE classes and FFZ sessions in levels of sedentary time and MVPA in youth with DD, as well as differences in PE teacher engagement/promotion of PA, and youth social interactions.

METHOD

Participants and Procedure

Participants were 23 children (17 males) ranging in age from 8 to 17 years (mean age =13.4; SD= 2.3) split into three groups; elementary (n=7), middle (n=11), and high school (n=5). Observations occurred during participants' regularly scheduled PE classes. The same PE teacher taught all PE classes. The majority of participants were White (N=19, 82.6%), and male (N=17, 73.9%); nearly half diagnosed with ASD (N=10, 43.5%), with the remaining participants diagnosed with other developmental disabilities (e.g., ADHD, learning disability). Demographic characteristics are displayed in Table 1. Study procedures were approved by the lead author's Institutional Review Board. Prior to observation, school consent, informed parent consent, and participant assent was obtained.

Table 1: Descriptive statistics for study participants

Demographics	N	%
Sex		
Male	17	73.9
Female	6	26.1
Ethnicity		
White	19	82.6
Black	4	17.4
Primary Diagnosis		
Autism Spectrum	10	43.5
Other	13	56.5
Secondary Diagnosis		
ADHD	2	8.7
Other	1	4.3
Medical Conditions		
Corrected Vision	10	43.5
Asthma/Allergies	2	8.6
Seizures	1	4.3
Brain Tumor	1	4.3
Body Mass Index		
Not Overweight	13	56.5
Overweight/Obese	10	43.5
	Range	**Mean(SD)**
Age (years)	8-17	13.4 (2.3)
Grade	3-10	7.2 (2.1)

Phase 1: Traditional PE: Data collection for this study took place in two phases on Mondays, Wednesdays and Fridays during scheduled PE time. During Phase 1, traditional PE was observed over 10 non-consecutive days during spring 2015. PE classes were 40 min in duration. Each PE class began with a 10-15 min warm up (e.g., 8 minute run, jog, or walk and

stretching) followed by 25-30 min of traditional PE (e.g., ultimate Frisbee, basketball, circuits, kickball, baseball, etc.).

Phase 2: Fitness Funzone®: During Phase 2, implementation of the FFZ was observed over 10 non-consecutive days (different 10 days from Phase 1) during spring 2015. FFZ took place during scheduled PE time and began with a similar 10-15 min warm up as the typical PE class (e.g., 8 minute run, jog, or walk and stretching) followed by 25-30 min of the FFZ. FFZ consists of outdoor and indoor components. For this study, only the indoor activity station program was used due to space limitations. The indoor activity program consists of a main game mat that has several different visually depicted activities and exercises (e.g., run in place, crunches, sit ups, gorilla jumps, etc.) with the number of repetitions visually written underneath the exercise, team dice, a team bean bag to move around the board, and smaller team mats that are placed around the perimeter of the space. The purpose of the game is to be the first team to complete all of the exercises specified on the main game mat. Students are separated into teams, (groups of two to four students, depending on the number of students in the class), and each team is assigned a team color. All players start on their team mat. On the teachers' instruction one person from each team runs to the main activity mat, rolls their corresponding colored dice, and moves their team's bean bag the amount of spaces indicated by the dice. Once students determine the exercise and number of repetitions from the main game mat, they run back to their team mat, relay the information to their team members, and all team members complete the specified exercise. Once all team members finish, youth participants rest while the next team member completes a similar process. This practice was the same across all FFZ days. Prior to implementation, the PE teacher had the opportunity to review the relevant FFZ documents, and was encouraged to ask any questions to research assistants.

Physical Activity Assessment

Physical activity levels were objectively measured by ActiGraph GT3X+ accelerometers (ActiGraph LLC, Pensacola, FL) placed on each student's right hip [38]. Accelerometers were placed on children as they arrived to PE by trained research staff. Children were then allowed to participate in their regularly scheduled PE class and accelerometers were removed as they left. Time on (when children arrived to PE) and time off (when children left PE) was recorded for all children. Accelerometers have effectively been used in studies involving children with ASD and other DD [4,7,39-41]. Accelerometer data was distilled using 5-second epochs to account for children's sporadic and transitive movement [42-44]. Cut points associated with sedentary time and MVPA in youth with ASD and other DD were used to distill the data [45].

Observation of PA Environment

A modified version of the System for Observing Children's Activity and Relationships during Play [46] was used to record children's pro- and anti-social behaviors. In order to assess teacher promotion of and engagement in PA the SOCARP observation protocol was modified to include some of the supplemental codes of the Motivational Climate Observation Tool for Physical Activity (MCOT-PA; [47;48]). Given research has shown that stereotypic and repetitive self-stimulatory behaviors can substantially interfere with learning and positive social interactions and integration within PE [10], and that PA can help reduce the frequency and intensity of these behaviors in youth with DD during PA, a code for presence or absence of stereotypic or self-stimulatory behaviors (1=observed, 0=not observed) was also included. SOCARP uses interval recording, with a 10-second observe and 10-second record cycle to assess observed levels of youth PA, staff/student ratio, and physical (e.g: presence of PA equipment) and social (i.e., group size, social interactions) environmental supports for PA. All youth in each class were observed at least once during traditional PE and FFZ. Data collectors were trained to conduct the SOCARP, and consistent with previous research [46,48,49], interrater reliability was established prior to, and periodically throughout, the data collection period. Two trained research staff observed each PE class. Reliability for SOCARP and modified MCOT-PA codes was estimated by calculating inter-observer percent agreement across a subset of active data collection days using the formula $\left(\frac{total\ number\ agreed}{total\ number\ observed}\right) * 100$). Inter-observer agreement, based on % scans, was acceptable to high across all observed variables (85 – 100%).

Statistical Analysis:

All accelerometer data were transformed into percent of time children spent sedentary and engaged in MVPA for each PE period. Repeated measures mixed effects models, accounting

for multiple measures per child, were used to estimate differences in the percent of time children spent sedentary and engaged in MVPA during traditional PE versus FFZ. Models were not run separately for gender due to the small number of girls in the sample, and because there was not a significant difference between males' (M = 43, SD = 14.9) and females' (M = 44, SD = 15.5) sedentary time; t(397) = -0.49, p = 0.62 or males (M = 25.1, SD = 12.1) and females (M = 24.4, SD = 12) MVPA; t(397) = 0.58, p = 0.56. To examine differences in peer interactions, and staff engagement by PE condition, chi-square tests were used when possible. For some peer interaction variables (i.e., negative verbal behaviors, antisocial behaviors, ignores peers), an insufficient number of instances were observed precluding the use of a chi-square test. All statistical analyses were performed using Stata (v.13.1, College Station, TX). Statistical significance was set at $p<0.05$.

Table 2: Percentage of Moderate-to-Vigorous Physical Activity (MVPA) and sedentary activity by school age

Group	N	Child Observations	MVPA (% of time)							Sedentary (% of time)						
			PE	SD (±)	FFZ	SD (±)	ABS Diff [1]	95% CI		PE	SD (±)	FFZ	SD (±)	ABS Diff [1]	95% CI	
Overall	23	399	33.4	11.4	53.3	11.1	**19.9**	(17.6,	21.5)	31.5	11.1	18.1	8.7	**-13.4**	(-14.9,	-11.6)
Elementary School	7	131	34.1	6.5	47.0	10.0	**12.9**	(10.2,	15.4)	34.8	7.9	23.1	8.8	**-11.7**	(-14.4,	-9.2)
Middle School	11	187	35.8	13.0	56.0	9.7	**20.2**	(17.0,	22.9)	31.1	12.7	17.6	7.8	**-13.5**	(-16.1,	-10.8)
High School	5	81	26.4	11.3	57.1	11.7	**30.7**	(25.4,	35.1)	27.1	9.8	11.8	5.5	**-15.3**	(-18.6,	-11.9)

[1]Bolded values indicate statistical significance at $p<0.05$; SD = Standard Deviation, FFZ = Fitness Fun Zone, ABS Diff = Absolute percent difference

RESULTS

Table 2 displays mean percentages of time spent sedentary and in MVPA, including model derived differences comparing traditional PE and FFZ across the study sample (overall) and the three distinct groups (elementary, middle, high school). Statistically significant reductions were found in the percent of time spent sedentary during FFZ in comparison to traditional PE sessions for all grade levels combined (-13.4%) and for each grade level separately. The largest reduction in sedentary time was found in the high school group (-15.3%) and the smallest reduction was found in the elementary school group (-11.7%). Further, statistically significant increases were found in the percent of time spent in MVPA during FFZ in comparison to traditional PE sessions overall (19.9%) and within all three groups. The largest MVPA differences were found in the high school group (30.7%) and the smallest MVPA differences were found in the elementary school group (12.9%).

Table 3 displays PE teacher interactions, PE teacher engagement, and peer interactions during traditional PE and the FFZ. For PE teacher interactions, the teacher was observed actively promoting PA more often in the FFZ condition than for traditional PE (x^2 (1) = 88.27, $p<.05$), but was engaged in PA activities more often during traditional PE than in the FFZ condition (x^2 (1) = 50.27, $p<.05$). For peer interactions, the only significant association was between PE condition and "engaged with peers, but not a coded interaction" (x^2 (1) = 15.33, $p<.05$). During the traditional PE condition, "engaged with peers, but not a coded interaction" was observed more often than for FFZ. Associations between PE condition and PE teacher interactions were not found for positive verbal (x^2 (1) = 1.60, $p>.05$) or prosocial behaviors (x^2 (1) = 0.29, $p>.05$).

Table 3: PE teacher interactions and engagement, and peer interactions during FFZ and traditional PE sessions

	Staff Promotes PA N (%)				Staff Engaged N (%)				Engaged with Peers, but no Code-able Interaction N (%)		
	Not Observed	Observed	Total		Not Observed	Observed	Total		Not Observed	Observed	Total
Traditional PE	2535 (90)	281 (10)	2816		2157 (77)	658 (23)	2815		40 (1)	2779 (99)	2819
Fitness Fun Zone	1611 (81)	390 (19)	2001		1699 (85)	302 (15)	2001		62 (3)	1968 (97)	2030
	x^2	df	p		x^2	df	p		x^2	df	p
Chi Square	88.269[a]	1	.000		50.270[a]	1	.000		15.325[a]	1	.000

DISCUSSION

This study is the first to examine traditional PE compared to FFZ, an activity station program that can be used as a unit during PE, in a sample of youth with DD. The findings from this study show FFZ can lead to a greater accumulation of MVPA and a reduction in the time spent sedentary during PE for youth with DD. The results from this study align with findings from previous studies indicating that activity stations, and similarly structured PA opportunities, are an enjoyable and feasible interventions to increase MVPA [32,36,37] and are effective for youth with DD [50].

The elementary group had the smallest change in percent of time spent in MVPA from traditional to FFZ (12.9%), compared to the high school group who had the largest change (30.7%). Given nationally representative studies have consistently shown significant decreases in MVPA during the transition from childhood to adolescence [51,52], our finding that levels of MVPA during FFZ were higher for adolescents in our sample is particularly encouraging. One reason for this might be that the FFZ, specifically for adolescent participants, utilized smaller groups (i.e: one to two people per team based on overall group size) and was less competitive than traditional PE games, which may have reduced commonly reported anxieties and dislike of PA-related activities in this age-group [53-55]. Thus, it appears that small sided, non-competitive games are a promising PA strategy for adolescents with DD.

Outcomes from the systematic observation demonstrated that the PE teachers' encouragement and positive reinforcement was likely one mechanism through which FFZ promotes higher MVPA than the typical PE class. That is, during the FFZ condition, the PE teacher was more often observed delivering verbal encouragement and positive reinforcement for PA, and in turn, these teacher behaviors were related to higher levels of youth PA within our study. This finding is consistent with past literature [30] that found social engagement with adults was positively correlated with levels of PA among youth with ASD. However, staff engagement, which has previously been associated with increases in time spent in MVPA, [56-58] was higher during traditional PE. One potential explanation for these findings is that traditional PA-related activities (e.g: tag, team sports) typically involve larger groups during play and more opportunities for teacher engagement, where FFZ activities involve several small groups, which make teacher engagement in the games more difficult. Informal communication with the PE teacher confirmed that he found engagement with the children during FFZ to be more difficult than during traditional PE because there were many different teams engaged in many different activities at the same time. This required increased supervision on the teacher's part and less time to engage in activities with the children.

Another novel finding was the lack of association between traditional PE and participant's social interactions with each other. Studies examining relations between peer social interactions and PA have reported significant associations between these variables among TD and youth with DD [59]. One potential explanation may be that there are additional factors mediating or moderating these relationships, or that our current measure of social interactions was not sensitive enough to detect relationships that were present. In the present study,

prosocial (0.9-1.1%), positive verbal (0.4-0.5%), negative peer interactions (0-0.1%), and ignores peers (0%) were rarely observed. Thus our observational tool may not have captured sufficient variance in peer interaction to detect a relationship ("engaged with peers, but not a coded interaction" was coded during 98% of intervals).

Strengths of this study include the use of accelerometers to objective measures to capture physical activity and sedentary time, focusing on children with DD since they are commonly excluded from similar studies, the multiple repetitions of both conditions (traditional PE vs. FFZ), the large number of child observations, and the consistency of the experimental conditions (e.g: equipment, space, PE teacher). Of particular importance is the emphasis of the present study on evaluating and improving services for an underserved population (i.e: youth with DD) who also have a demonstrated and urgent need (i.e: increased PA opportunities).

LIMITATIONS AND FUTURE DIRECTIONS

This study also has limitations that must be considered when interpreting the data. The study was conducted in one PE setting, by one teacher with significant experience with youth with DD; thus, the findings may not be generalizable to youth with DD in other settings. Further, the small sample size and the low number of females compared to males may also limit generalizability. However, it is not surprising that the sample consisted of predominantly males since ASD is diagnosed in males four times more often than in females [1]. Another limitation of the present study was the potential for order effects due to the fact that all youth participants in our sample experienced both conditions in the same order. While a design in which two groups experienced each of the conditions in opposite order (counterbalanced) would have been preferred, dividing the small sample available to us would have substantially diminished the power of our study.

Further, the present study included some dissatisfaction among youth participants with the range of activities offered by FFZ. The PE teacher stated that some youth complained that the selection of exercises on the board never changed. This issue requires attention due to reports that boredom with PA activities is a common barrier for youth with DD [53,55]. Future iterations of this intervention may include greater variation in the activities on the board (e.g: skipping, crab-walk, bear-crawl vs. running) or offering a choice of activities on some spaces. Alternatively, intervention staff could solicit youth input regarding exercises that could be incorporated into the exercise board. Lastly, this program was tested in youth with DD, thus more information is needed to determine if this program is also beneficial for TD youth.

In conclusion, implementing the FFZ can potentially maximize the amount of time children with DD spend in MVPA and reduce sedentary time during PE. This was particularly true for older adolescents with DD, the subsample within the youth population at greatest risk for inactivity [21,59-61]. The increase in MVPA found during the specialized PE class (FFZ) not only exceeds levels typically reported for youth with DD [15,18,20], but also PE physical activity levels reported for TD youth [19,51]. Further research is needed to confirm these results in TD children; however, the FFZ appears to be an effective and feasible intervention to increase health-enhancing physical activity behaviors for youth with DD, and warrants consideration as part of PE curricula.

Conflicts of Interest

It is my ethical obligation as a researcher to report that Peaceful Playgrounds, Inc made an unrestricted gift of the Fitness Funzone toolkit (retail value $3,025) for the conduct of this study. Peaceful Playgrounds had no input into the design, analysis, or interpretation of the research reported in this manuscript.

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