Physical Activity and Sedentary Time among Children with Disabilities at School

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ABSTRACT

SIT, C. H. P., T. L. MCKENZIE, E. CERIN, B. C. CHOW, W. Y. HUANG, and J. YU. Physical Activity and Sedentary Time among Children with Disabilities at School. *Med. Sci. Sports Exerc.*, Vol. 49, No. 2, pp. 292–297, 2017. **Purposes**: Physical activity (PA) is important for the development of children with disabilities, but rarely does this population meet the recommended standards. Schools are salient locations for PA, but little is known about how specific school settings affect the PA of children with diverse disabilities. We assessed PA and sedentary time (ST) of children with disabilities in three school settings (physical education, recess, lunchtime). **Methods**: Participants included 259 children from 13 Hong Kong special schools for five primary disabilities: visual impairments, hearing impairments, physical disabilities, intellectual disabilities, and social development problems. Children wore accelerometers at school for 3 d, and the time (min and %) they engaged in moderate-to-vigorous PA (MVPA) and ST was extracted for each school setting by sex. Analyses included multiple linear mixed models to determine differences in MVPA and ST by sex across disability types, adjusting for body mass index, grade level, and duration in each setting. **Results**: Overall, children spent 70% of their day at school being sedentary and accrued little MVPA (mean, 17 ± 4.2 min daily). Children with intellectual disabilities (severe) had especially low levels of MVPA. All three settings contributed significantly to both MVPA and ST, with recess contributing more to MVPA than physical education or lunchtime. **Conclusions**: This is the first study to examine MVPA and ST among different disability types at school using accelerometry. Given the low levels of PA, this population should receive priority in the development of cost-effective interventions to improve their PA opportunities. **Key Words:** ACCELEROMETER, HEALTH, YOUTH, SPECIAL NEEDS, RECESS, PHYSICAL EDUCATION

Physical inactivity is a serious public health problem, and the association of physical inactivity with obesity and obesity-related chronic diseases in children is well documented (35). Healthy People 2020 reaffirms the importance of physical activity (PA) and identifies "Disability and Health" as one of the topic areas that require further investigation (33). Evidence indicates that children with disabilities do not meet the recommended 60 min·d^{-1} of moderate-to-vigorous PA (MVPA) (24). Compared with their typically developing peers, children with disabilities are much less physically active, tend to engage more in sedentary pursuits, and are at three to six times greater risk for obesity (18). Increasing PA in children with disabilities is therefore important for reducing the prevalence of obesity as well as a number of secondary conditions, and thus is a public health priority (33).

Social–ecological models of health behavior that focus on environmental influences on PA are becoming more widely used in research (15). Schools, for example, are important settings where children can engage in health-promoting PA during the day (21,35), and the Institute of Medicine's recent report suggests that schools should provide at least 50% of the 60 min of daily recommended MVPA (14,34). Sample standards or guidelines for PA at schools include having daily active physical education (PE) (i.e., at least 50% lesson time in MVPA) (21,32), daily recess of at least 20 min (17), and after school programs that engage children in any PA for at least 17% of the time (1). Previous studies suggest that PE contributes modestly to total daily MVPA and that recess and afterschool programs can contribute up to at least a third of the recommended levels (23,31).

In Hong Kong, the Education Bureau recommends that 5%–8% of the total school curriculum time be allocated to PE (equivalent to 70–80 min·wk^{-1}) (7). There are no specific guidelines, however, for time allocations for recess or other PA settings in special schools. Meanwhile, direct observation studies indicate that Hong Kong children with disabilities accrue little PA during recess and PE (30), and that during recess and lunchtime, they may accrue more PA than during

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on campus before and after school periods (28). Additional research, especially using objective methods, needs to be conducted among children with disabilities to understand the contributions of structured settings to PA and sedentary behavior at school.

A recent study using accelerometers during PE and recess reported that the children with intellectual disabilities did not meet recommended levels for PA during these school settings (19). Other studies have also used accelerometers to examine PA and sedentary time (ST) with children with physical (22,26) and intellectual disabilities (10). Regardless of disability type, children tend to spend a small amount of school time in MVPA and a great amount in sedentary pursuits. For example, Bingham et al. (2) examined both MVPA and ST of children with autism, behavioral, and emotional challenges, and other special needs. They found those with behavioral and emotional needs were more active than others, but over 80% of the children failed to meet PA guidelines. Although these studies are important, additional investigations are needed to advance the understanding of PA and ST of children with diverse types of disabilities during school time. The purpose of the present study was to use accelerometry to objectively assess the PA and ST of boys and girls with different disability types in school PA settings including PE. A secondary purpose was to determine the relative contributions of the accrual of PA and ST in these settings to overall school MVPA and ST in children with disabilities.

METHODS

Participants. During the 2013–2014 school year, 7834 children were enrolled in 60 Hong Kong special schools (excluding one English Foundation Special School) (9). With the exception of hospital schools, special schools for five main disability types were in operation: visual impairment (VI) (n = 2), hearing impairment (HI) (n = 2), physical disability (PD) (n = 7), intellectual disability (ID) (n = 41), and social development (SD) (n = 7). These schools typically housed grades 1–12 and provided educational services to one class of students per grade level composed of 10–15 students (except for children with VI). Our cross-sectional study, conducted between November 2013 and March 2014, included 313 Chinese boys and girls enrolled in 13 of the special schools selected using a purposive sampling method. These individual schools and their curricula were designed specifically for children with VI, HI, PD, ID (mild, moderate, severe), and SD problems. Written informed parental consent and child assent were obtained for each participant. The study complied with the principles of the Declaration of Helsinki and was approved by the Joint Chinese University of Hong Kong-New Territories East Cluster Clinical Research Ethics Committee.

Measures. Children's PA levels were assessed using accelerometry (GT3X model; ActiGraph, Pensacola, FL), an objective and widely used measure of PA in children, including those with disabilities (4). With the assistance of trained research assistants and teachers, children wore the accelerometer on an elastic belt above the right hip at school during three normal weekdays spread over a 1-month period. Data were collected in a 15-s epoch, and the original counts were quantified into either ST (≤100 counts per minute) or MVPA (≥2296 counts per minute) based on the cutoff points suggested by Evenson et al. (11). Evenson cutpoints have been used and/or validated previously with children with disabilities (4–6). The amount of time children engaged in ST and MVPA were extracted from the times they participated in structured PA programs in six different settings (i.e., before school, regular PE classes, recess, lunchtime, after school, and rehabilitation sessions) during the three measurement days. Participants' height and weight were obtained from the schools, and body mass index (BMI) was calculated.

Statistical analysis. Mean and standard deviations were calculated to describe time in each setting and total wear time. We examined MVPA and ST during overall school time and during three separate settings (PE, recess, and lunchtime). Of 13 schools, only five schools provided before and after activity programs or rehabilitation sessions, so these contexts were not analyzed separately. To compare children's MVPA and ST across disability types in different settings, linear mixed models (LMM) were performed. LMM were chosen because they can deal with incomplete data sets with repeated measures (i.e., three measurement days) and adjustments for school-level clustering. Children with ID of severe level were taken as a reference category in LMM. Models, adjusting for BMI, grade level, and duration of the specific school setting (PE, recess, and lunchtime) were estimated for boys and girls separately. The contribution of time–segment MVPA and ST for each of the three settings to overall school MVPA and ST by sex were further determined by LMM, adjusting for BMI, grade level, and wear time. Statistical analyses were performed using SPSS version 22.0, and P value was set at 0.05.

RESULTS

Of the 313 students initially recruited to participate in the study, 23 were not categorized into a specific disability type, eight had missing gender information, 15 with PD needed walking assistance or were wheelchair bound, and eight students did not have valid accelerometer data for at least 1 d. They were excluded from all analyses, resulting in a final dataset of 259 students (mean age, 13.04 ± 4.45 yr; range, 6–23 yr), most of whom (71.8%) were children with ID (Table 1). The

TABLE 1. Number of children by disability type and sex (total n = 259).

Type of Special School	Boys	Girls	Total
Visual impairment	11	10	21
Hearing impairment	7	5	12
Physical disability	14	13	27
Intellectual disability (mild)	55	37	92
Intellectual disability (moderate)	36	23	59
Intellectual disability (severe)	18	17	35
Social development problems	13	0	13
Total	154	105	259

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TABLE 2. Time spent in MVPA and ST at school overall and in three specific settings.

Time Segment	N	Duration (min)			%MVPA		%ST	
		Mean	Standard Deviation	Range (min)	Mean	Standard Deviation	Mean	Standard Deviation
Wearing time	259	412.7	46.6	126–603	4.2	3.4	70.0	13.1
PE lessons	178	54.9	18.3	30–95	13.2	12.4	49.4	24.2
Recess	247	31.6	10.7	15–55	9.4	11.1	49.5	24.2
Lunch time	246	65.2	12.8	40–90	4.5	6.2	69.0	17.2

Children wore accelerometers throughout the school day; only three school settings are reported in detail in this article.

grade level and BMI of children excluded from data analyses did not differ from those retained. Table 2 shows that students wore the accelerometers at school for an average of 412.7 $min \cdot d^{-1}$ (6.9 h). Overall, they spent 17 min (4.2%) of the school day in MVPA, 106 min (25.8%) in light PA, and 289 min (70.0%) in ST. Specific to the three settings, children spent an average of 7.2 min (13.2%) engaging in MVPA during PE, 3.0 min (9.4%) during recess, and 2.9 min (4.5%) during lunchtime.

Table 3 compares the total daily MVPA and ST at school by sex across the disability types. After controlling for confounders, boys with mild ID, moderate ID, and SD problems were more physically active than boys with severe ID. Boys with severe ID were more sedentary than boys with other disability types. Among girls, there were no significant differences in MVPA across the disability types. Girls with VI, mild ID, and severe ID, however, were less sedentary than girls with severe ID.

Tables 4 to 6 compare MVPA and ST for boys and girls during PE lessons, recess, and lunch periods across the disability types, with adjustments for BMI, grade level, and specific school setting. Table 4 shows that, compared with boys with severe ID, boys with VI and SD problems had significantly more MVPA min (VI: b = 16.17; 95% confidence interval [CI], 7.05–25.05; SD problems: b = 18.00; 95% CI, 8.91–27.08) and less ST (VI: b = −30.84; 95% CI, −45.54 to −16.15; SD problems: b = −28.37; 95% CI, −42.96 to −13.78) during PE. Similar differences in MVPA and ST were not found for recess and lunchtime (Tables 5 and 6); boys with severe ID, however, were more sedentary during lunchtime than boys with other disability types (Table 6). Among girls, those with VI spent more time in MVPA (b = 15.49; 95% CI, 8.08–22.90) and less ST (b = −24.02; 95% CI, −47.86 to −0.19) during PE lessons than those with severe ID (Table 4). Similar to boys with severe ID, girls with severe ID were more sedentary during lunchtime than girls with other disability types (except moderate ID) (Table 6).

After adjusting for sex, BMI, grade level, and wear time, results indicated that all three school settings contributed significantly to both overall MVPA and ST during the school day. Specifically, recess contributed significantly more to both overall MVPA and ST than PE and lunchtime. Comparatively, a 1-min increase in MVPA during recess (b = 1.24; 95% CI, 0.99 to 1.49) was associated with 1.24-min increase in daily MVPA at school, whereas a 1-min increase during PE (b = 1.11; 95% CI, 0.92 to 1.29) and lunchtime (b = 1.04; 95% CI, 0.77 to 1.31) was associated with 1.11 and 1.04 min increases, respectively. Similar findings were also obtained for boys and girls, with recess being contributing the most to overall MVPA (boys: b = 1.34; 95% CI, 1.02–1.66; girls:

TABLE 3. Comparison of MVPA (min) and ST (min) at school by sex across disability types.

	MVPA (min)		ST (min)	
	Coefficient	95% CI	Coefficient	95% CI
Boys				
BMI	0.24	−0.12 to 0.61	−0.99	−2.14 to 0.15
Grade level	−0.07	−0.43 to 0.30	**4.09**	**2.93 to 5.25**
Total wearing time	**0.09**	**0.06 to 0.13**	**0.57**	**0.47 to 0.67**
Disability type (reference: ID-severe)				
VI	7.69	−1.19 to 16.58	**−28.58**	**−50.38 to −6.77**
HI	−1.01	−10.11 to 8.08	**−39.35**	**−63.81 to −14.89**
PD	−2.03	−9.95 to 5.90	**−24.83**	**−45.71 to −3.96**
ID-mild	**14.88**	**7.95 to 21.82**	**−72.20**	**−89.19 to −55.21**
ID-moderate	**13.29**	**5.98 to 20.59**	**−74.47**	**−92.12 to −56.82**
SD problems	**19.88**	**10.94 to 28.81**	**−79.45**	**−102.42 to −56.47**
Girls				
BMI	0.26	−0.10 to 0.63	**−2.24**	**−4.01 to −0.48**
Grade level	−0.08	−0.48 to 0.32	**3.40**	**1.47 to 5.31**
Total wearing time	**0.07**	**0.03 to 0.10**	**0.57**	**0.41 to 0.72**
Disability type (reference: ID-severe)				
VI	11.54	−4.28 to 27.37	**−42.92**	**−80.73 to −5.11**
HI	−2.03	−17.20 to 13.13	−17.06	−56.54 to 22.42
PI	4.83	−8.55 to 18.21	−29.72	−63.50 to 4.07*
ID-mild	9.01	−3.01 to 21.04	**−56.71**	**−86.40 to −27.01**
ID-moderate	5.61	−6.39 to 17.62	**−56.86**	**−88.15 to −25.56**

Findings are presented as regression coefficients and 95% CI and were based on LMM with school as random effects and assessment days as a repeated-measure variable. The models were adjusted for BMI, grade level, and total wearing time. Regression coefficients represent the difference in MVPA or ST in minutes, compared with the severe ID group. Statistically significant results are in bold emphasis.
*$0.05 < P < 0.1$.

TABLE 4. Comparison of MVPA (min) and ST (min) during PE lessons in different types of special schools.

	MVPA (min)		ST (min)	
	Coefficient	**95% CI**	**Coefficient**	**95% CI**
Boys				
BMI	−0.06	−0.31 to 0.19	0.03	−0.44 to 0.51
PE duration	0.04	−0.03 to 0.11	**0.76**	**0.62 to 0.89**
Grade level	0.02	−0.28 to 0.33	−0.31	−0.86 to 0.27
Disability type (reference: ID-severe)				
VI	**16.17**	**7.05 to 25.05**	**−30.84**	**−45.54 to −16.15**
HI	0.31	−8.87 to 9.49	0.54	−14.37 to 15.45
PD	1.46	−7.63 to 10.54	−7.43	−22.01 to 7.14
ID-mild	6.90	−0.18 to 13.99*	−9.62	−21.07 to 1.83*
ID-moderate	5.25	−1.89 to 12.39	−5.61	−17.19 to 5.97
SD problems	**18.00**	**8.91 to 27.08**	**−28.37**	**−42.96 to −13.78**
Girls				
BMI	−0.12	−0.39 to 0.16	0.01	−0.71 to 0.74
PE duration	0.00	−0.06 to 0.07	**0.86**	**0.68 to 1.03**
Grade level	0.25	−0.07 to 0.58	−0.46	−1.34 to 0.42
Disability type (reference: ID-severe)				
VI	**15.49**	**8.08 to 22.90**	**−24.02**	**−47.86 to −0.19**
HI	0.28	−7.46 to 8.02	−2.32	−26.59 to 21.96
PD	5.67	−1.68 to 13.02	−15.18	−38.86 to 8.50
ID-mild	3.06	−2.78 to 8.90	−2.66	−21.26 to 15.94
ID-moderate	1.94	−3.94 to 7.82	−0.47	−19.18 to 18.24

Findings are presented as regression coefficients and 95% CI and were based on LMM with school as random effects and assessment days as a repeated-measure variable. The models were adjusted for BMI, grade level, and duration of PE lessons. Regression coefficients represent the difference in MVPA or ST in minutes, compared with the severe ID group. Statistically significant results are in bold emphasis.
*$0.05 < P < 0.1$.

b = 1.05; 95% CI, 0.51–1.58), followed by PE (boys: b = 1.05; 95% CI, 0.82–1.29; girls: b = 1.02; 95% CI, 0.76–1.29), and lunchtime (boys: b = 1.04; 95% CI, 0.60 to 1.49; girls: b = 1.00; 95% CI, 0.69–1.32).

DISCUSSION

Given the important role of schools in promoting children's PA, the accurate identification and assessment of PA opportunities conducive to increasing children's PA is critical to developing suitable school-based PA promotion strategies (3,21). Children's PA is greatly influenced by the immediate environment, and in Hong Kong, it is the policy that children with disabilities are educated in schools designed to address specific disabilities. To investigate school settings using the socioecological approach, this study is the first to examine the accelerometer-assessed PA and ST of children with different disability types across PE, recess, and lunch periods in Hong Kong special schools while adjusting for

TABLE 5. Comparison of MVPA (min) and ST (min) during recess among different types of special schools.

	MVPA (min)		ST (min)	
	Coefficient	**95% CI**	**Coefficient**	**95% CI**
Boys				
BMI	−0.00	−0.11 to 0.11	−0.18	−0.37 to 0.01
Recess duration	0.16	−0.04 to 0.36	0.18	−0.00 to 0.37
Grade level	−0.03	−0.14 to 0.08	0.32	−0.02 to 0.65
Disability type (reference: ID-severe)				
VI	2.34	−7.34 to 12.01	−7.90	−24.06 to 8.26
HI	−0.00	−9.66 to 9.66	−4.79	−20.09 to 10.52
PD	−2.34	−12.16 to 7.47	3.74	−11.63 to 19.10
ID-mild	1.41	−6.90 to 9.72	−4.45	−17.84 to 8.94
ID-moderate	1.92	−6.41 to 10.24	−5.70	−19.10 to 7.70
Girls				
BMI	0.08	−0.01 to 0.17	−0.14	−0.37 to 0.10
Recess duration	0.01	−0.06 to 0.08	**0.32**	**0.06 to 0.57**
Grade level	−0.08	−0.17 to 0.02	**0.53**	**0.28 to 0.78**
Disability type (reference: ID-severe)				
VI	2.50	0.01 to 5.01*	−9.71	−19.73 to 0.30*
HI	0.65	−1.89 to 3.19	−3.83	−13.82 to 6.14
PD	2.78	−0.10 to 5.65*	−3.41	−14.39 to 7.58
ID-mild	2.27	−0.16 to 4.70*	−6.75	−15.98 to 2.48
ID-moderate	1.58	−0.85 to 4.00	−5.14	−14.39 to 4.11

Note: recess was reported in all schools except for social development problems (boys). Findings are presented as regression coefficients and 95% CI and were based on LMM with school as random effects and assessment days as a repeated-measure variable. The models were adjusted for BMI, grade level, and recess duration. Regression coefficients represent the difference in MVPA or ST in minutes, compared with the severe ID group. Statistically significant results are in bold emphasis.
*$0.05 < P < 0.1$.

TABLE 6. Comparison of MVPA (min) and ST (min) during lunch periods among different types of special schools.

	MVPA (min)		ST (min)	
	Coefficient	**95% CI**	**Coefficient**	**95% CI**
Boys				
BMI	0.04	−0.07 to 0.16	−0.21	−0.50 to 0.08
Lunch time duration	0.04	−0.05 to 0.13	**0.70**	**0.47 to 0.92**
Grade level	**0.16**	**0.04 to 0.27**	−0.10	−0.39 to 0.18
Disability type (reference: ID-severe)				
VI	**4.52**	**0.74 to 8.30**	**−14.89**	**−24.24 to −5.55**
HI	0.70	−3.11 to 4.50	**−11.31**	**−20.73 to −1.90**
PD	1.47	−1.83 to 4.77	**−11.83**	**−20.00 to −3.65**
ID-mild	**3.75**	**0.82 to 6.68**	**−15.71**	**−22.96 to −8.47**
ID-moderate	2.77	−0.24 to 5.78*	**−12.04**	**−19.47 to −4.60**
Girls				
BMI	0.05	−0.07 to 0.16	**−0.40**	**−0.76 to −0.04**
Lunch time duration	0.04	−0.05 to 0.13	**0.65**	**0.44 to 0.85**
Grade level	**0.16**	**0.04 to 0.27**	−0.18	−0.57 to 0.21
Disability type (reference: ID-severe)				
VI	4.88	−90.77 to 100.53	**−17.14**	**−24.75 to −9.52**
HI	0.27	−23.83 to 27.38	**−9.50**	**−17.38 to −1.63**
PD	1.65	−36.09 to 39.39	**−8.92**	**−15.58 to −2.26**
ID-mild	2.33	−34.61 to 39.27	**−11.77**	**−17.81 to −5.74**
ID-moderate	−0.54	−26.10 to 25.02	−5.35	−11.81 to 1.11

Findings are presented as regression coefficients and 95% CI and were based on LMM with school as random effects and assessment days as a repeated-measure variable. The models were adjusted for BMI, grade level, and lunch time duration. Regression coefficients represent the difference in MVPA or ST in minutes, compared with the severe ID group. Statistically significant results are in bold emphasis.
*$0.05 < P < 0.1$.

potential confounders. In addition, we also examined the relative contributions of these settings to children's overall MVPA and ST in schools.

Consistent with previous studies (19,30), the present investigation showed that children with disabilities accrued little MVPA (about 17 min) during all day at school—an amount far short of recommendations (14). Meanwhile, the children spent more than 70% of their overall time at school being sedentary. Despite small amounts of MVPA, children could possible reach PA recommendations if other school or off campus PA opportunities were provided. After adjusting for confounding variables, all three school settings contributed statistically significant to children's MVPA and ST at school. Recess, however, contributed more MVPA than PE or lunchtime, confirming previous evidence that recess at school accommodates more PA accrual than PE (12,30). Observations in these three settings suggest there is potential for increasing the amount PA provided there without increasing session length (e.g., via improved management and provision of loose equipment).

Previous studies have shown that PA levels vary as a function of both disability type and sex, with boys and children with hidden disabilities (e.g., SD problems) being more physically active than their counterparts (27,30). When compared with the total daily MVPA and ST at school across the disability types, boys with mild ID, moderate ID, and SD problems were found to be more active than boys with severe ID. The severity of disability relates to children's PA (27), and special schools that provide more social and environmental support for PA are likely to promote more PA (19,29). Meanwhile, children with severe ID, the least active group, should be considered to be at a greater risk for developing chronic diseases associated with physical inactivity and be a priority target group for PA interventions (16).

Children's MVPA and ST differed across the three school settings. During PE, boys with VI and SD problems had more MVPA and less ST than boys with severe ID. Similarly, girls with VI also had more MVPA and less ST than their female peers with severe ID. Compared with those with other disabilities, children with VI were found to be more active in the present study, contrary to earlier Sit et al. (30) findings. In Hong Kong, the special school for children with VI provides boarding facilities and specially adapted facilities and educational services. It implements student-oriented teaching, cross-level subject instruction, and individual education plans that are embedded into the school-based curricula especially designed to master the subjects and skill learning (8). It was also interesting to find that boys with VI were more active than their peers with severe ID during lunchtime. Determining what is exactly done to promote activity accrual for children with VI during PE and lunchtime periods in this school will require further investigation.

We had originally planned to analyze the data for all structured PA programs on the campuses, including those provided before/after school; schools, however, rarely provided PA sessions other than during PE, recess, and lunchtime. Not only did children have low MVPA and high ST across these three settings, they accrued only about 17 MVPA minutes throughout the school day. Thus, the entire school day needs to be targeted for intervention, not just the three specific settings. These interventions should focus on replacing ST with time spent moving, with higher intensity PA more likely to lead to greater health benefits (14).

There are numerous strengths to the study, including using accelerometry to objectively assess both the PA and ST of children with disabilities while controlling for confounders; separating the school day into three specific structured settings; and the recruitment of a large sample size representative of 22% of special school population in Hong Kong. Study limitations include a cross-sectional nature that prohibits detecting cause-and-effect relationships and the sample being from special schools only. Children attending mainstreamed/inclusive schools were not included, thus reducing generalizability of the results. Additionally, few structured before and after school PA programs and active rehabilitation sessions at the 13 schools prohibited an examination all the different possibilities where PA might occur at schools.

To the best of our knowledge, this is the first study to examine both the MVPA and ST of children among different disability types using accelerometry at schools. Overall children were very inactive at school, and an increase in their PA is much needed. Intervention studies to increase PA in schools among those with disabilities have not been conducted in Hong Kong, but changes in the school physical (e.g., increased play area usability and provision of equipment) and social (e.g., teacher support for PA) setting offer potential (13,20). We believe there is potential for the adaptation of evidence-based strategies shown to be effective with children without disabilities to those with special needs (25). Meanwhile, this segment of the population remains underresearched relative to sedentary-related problems, and we believe it should receive priority in the development and assessment of cost-effective, feasible interventions to improve their PA opportunities.

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