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Assessment of Measures of Physical Activity of Children with Cerebral Palsy at Home and School: A Pilot Study

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Abstract

Home and school are important settings where children can accrue health promoting physical activity (PA). Little is known about the PA levels and associated environmental characteristics at home and school in children with cerebral palsy (CP). An observational tool - Behaviors of Eating and Activity for Children's Health Evaluation System (BEACHES) - offers potential for providing information.

Objective: To validate BEACHES against Actigraph accelerometer and to document PA of children with CP at a special residential school facility for children with physical disabilities.

Methods: Five children with CP (2 girls, 3 boys; aged 9.82 ± 2.39 years) in Level I of the Gross Motor Function Classification System (GMFCS) participated. PA monitoring was conducted once a week during four consecutive weeks at morning recess at school and during after school hours at the children's residence. Estimates of time spent being sedentary and being active were derived from the Actigraph and compared to estimates obtained with BEACHES.

Results: Children's PA observed using BEACHES was comparable to the Actigraph estimations. In general, children were more active at recess than after school and the physical locations assessed by BEACHES were associated with objectively measured PA time.

Conclusion: This pilot study indicates that BEACHES appears to be a suitable measure of PA for children with CP in both home and school settings. Additional study with a larger and more diverse sample is recommended to verify the results.

Keywords: Physical activity; Cerebral palsy; Home and school; Observation; Children

Introduction

Cerebral palsy (CP) represents the largest diagnostic group treated in pediatric rehabilitation [1]. The hallmark impairment in children with CP is a disordered development of gross motor function that has a negative impact on physical activity (PA) levels. Children with CP are less physically active than typically developing peers, and to minimize health risks associated with sedentary living there is a growing need for a better understanding of potentially modifiable variables that are associated with PA in this population [2].

The International Classification of Functioning, Disability and Health (ICF) model recognizes the influence of environmental factors on impacting activity participation among persons with disabilities [3]. A recent review on correlates of PA using the ICF model suggested that environmental factors in home and school settings such as proximity and size of activity areas, social support from family and peers, and the availability of equipment significantly influenced the extent and intensity of PA in children with physical disabilities [4]. The Actigraph accelerometer has been identified as a valid objective measure of PA in children with physical disabilities, but it does not record important contextual aspects of PA. Meanwhile, direct observation methods do allow for the study of contextual variables associated with PA and they also simultaneously reduce the response burden of measurement on study children [5]. Nonetheless, observational methods could be susceptible to measurement error and validation is warranted.

The Behaviors of Eating and Activity for Children's Health Evaluation System (BEACHES) is a measurement system that documents children's PA and eating behavior, as well as associated environmental characteristics and events in homes and schools [6]. Research using BEACHES has shown that children are less active at home than during recess at school, and that time spent outdoors and prompts to be active at home are correlated strongly with PA. BEACHES have been validated for use in children, but it has not been tested with those with impaired movement control such as CP [6-8]. The atypical movement patterns of those with CP could possibly limit the direct application of PA intensity estimates that were established for typically developing children.

This paper reports on a pilot study aimed at examining the suitability of BEACHES for assessing PA and related variables among children with CP. We simultaneously collected PA data using Actigraph accelerometers and BEACHES from children with CP in a boarding school environment. We compared estimates of time spent in sedentary and active time between the two instruments to examine the

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validity of BEACHES. We also explored environmental and contextual factors that are related to PA through the components of BEACHES.

Methods

Participants

Five children with CP (2 girls and 3 boys) between ages of 6 and 12 years (9.82 ± 2.39 years) who were boarding students in a special school for children with physical disabilities participated. They lived in the school residential facility from Sunday evening until noon Friday. Four (2 girls and 2 boys) had been diagnosed with CP spastic diplegia and the fifth was diagnosed with CP dyskinesia. All were classified as Level I in the Gross Motor Function Classification System and had no medical conditions restricting their independent participation in daily living activities. Ethical approval for the study was granted by the university.

Physical activity assessment

Uniaxial accelerometer (MTI): The Actigraphs were initialized to record data at 30-second epochs and activity counts from them were analysed using cut-points suggested by Evenson et al. to estimate children's time spent sedentary and being active (moderate-to-vigorous PA) [9].

Behaviors of Eating and Activity for Children's Health Evaluation System (BEACHES): BEACHES is an observation instrument for simultaneously recording children's PA and related environmental contexts such as location, presence of others, and screen time use. BEACHES recordings were done on a 60-second cycle. Four assessors trained according to an established protocol, coded PA behaviour into five mutually exclusive categories: lying down, sitting, standing, walking, and vigorous activity, and the percentages of observations in specific activities were used to estimate time spent sedentary (lying down+sitting+standing)and active (walking+vigorous activities). Training continued until inter-observer agreement (IOA) among observers exceeded 85% and field reliabilities on PA during data collection exceeded 95%.

Procedures

PA was monitored once a week over four weeks during two distinct time periods and locations: (1) morning recess at school (20 min) and (2) evening leisure time at the child's school residence after dinner (60 min). Data were collected from Monday through Thursday on normal school days and the children were asked to continue their usual routines during these days.

Data analysis

To facilitate linear comparisons between the two sets of data, estimates of time spent in sedentary and PA were expressed in percentage of the observed time. Intra-class correlation coefficient (ICC) was calculated between BEACHES and Actigraph measures for sedentary and active time (MVPA for Actigraph). Estimates of time spent in the activity categories were also expressed in minutes, and Bland-Altman plots were used to examine the level of agreement between the Actigraph (criterion) and BEACHES (comparison) data [10].

Information from the other components of BEACHES was analyzed using descriptive statistics. Regression analyses were used to examine associations of time being sedentary and active as dependent variables and each environmental factor as an independent variable. To account for inter-individual variance, participants were included as fixed factors in the model in the form of N-1 dummy variables. Regression models were run in a hierarchical fashion whereby dummy variables representing participants were entered first in the models, followed by the individual environmental factors. The additional percentage of PA variance explained after entering a specific environmental factor represented the magnitude of association between the PA outcome and the environmental factor.

Results

Physical activity levels

Table 1 shows that the participants spent substantial portions of the observed time being sedentary. Based on the criterion measure, they spent 48.8 ± 9.7% and 57.5 ± 15.3% of the observed time being sedentary during recess and after school, respectively. Paired samples t-tests showed that they spent more time being active ($t=-2.54$, $p=.015$) and less time being sedentary ($t=2.14$, $p=.039$) during recess than after school. Similarly, BEACHES data show that the participants were more active ($t=-3.22$, $p=.003$) and less sedentary ($t=2.91$, $p=.006$) during recess than after school (Table 1).

Intra-class correlation coefficient (ICC) and level of agreement between comparison and criterion measures

Reliability analysis indicated high agreement between estimates derived from the two measures for both the sedentary (ICC=.78, $p< .001$) and active (ICC=.85, $p< .001$) categories. Bland-Altman plots (Figure 1) also showed high agreement between BEACHES and Actigraph in estimating the number of minutes being sedentary and active (MVPA for Actigraph). Specifically for active time, the Bland-Altman plots showed a mean difference of 1.1 minutes between the estimates of the Actigraph and BEACHES. Furthermore, the ± 1.96 SD value showed that overestimation did not go beyond 5.7 minutes, while underestimation did not go beyond 7.8 minutes. Consistent with the intra-class correlation coefficients, the Bland-Altman plots suggest that BEACHES is comparable to the Actigraph in estimating time spent being active (Figure 1).

Environmental factors based on BEACHES

During recess, children were outdoors 35.6% of the time, and when indoors they viewed media (videos) in classrooms 9.1% of the time. In contrast, during the after school observations the children were indoors the entire period and they viewed media (computer monitors) 8.8% of this time. Table 2 shows the extent to which specific environmental factors and inter-individual differences accounted for the variance in sedentary and active time. When outdoors, the children were less sedentary (predicting 38.8% of the variance) and engaged in greater active time (predicting 35% of the variance). All other environmental factors did not predict time spent in sedentary or active behavior (Table 2).

Discussion

This is the first study to validate an observation tool (BEACHES)

	Sedentary (Mean ± SD)		Active (Mean ± SD)	
	Actigraph	BEACHES	Actigraph†	BEACHES‡
Recess	48.8 ± 9.7	65.5 ± 10.9	36.5 ± 9.2	34.5 ± 10.1
After-school	57.5 ± 15.3	75.3 ± 10.4	27.3 ± 13.3	24.5 ± 9.8

† moderate-to-vigorous physical activity
‡ walking + vigorous activities

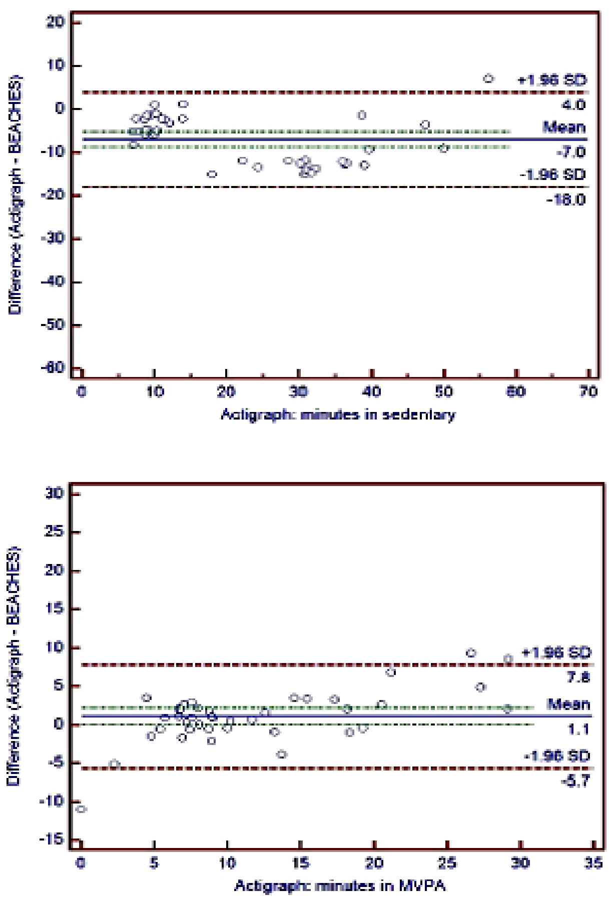
Table 1: Percentage of time spent in PA categories during recess and after-school observations based on the criterion (Actigraph) and comparison (BEACHES) measures.

against the Actigraph accelerometer, and to document PA of children with CP at residential special school facility for children with physical disabilities. The strong relationships (ICCs) found between the Actigraph (criterion) and BEACHES in this study support the validity of the PA estimates using BEACHES; as well, the Bland-Altman plots showed that the mean differences between BEACHES and the Actigraph measures of active time were generally small. Nevertheless,

Environmental Factors (No vs. Yes)	Coefficient of Determination (R^2)			
	Sedentary	*p*	Active	*p*
Location: Outdoors	.388	.004	.350	.009
Media viewing	.024	.974	.180	.218
Presence of adults	.030	.955	.194	.177
Presence of children	.243	.080	.190	.187
Motivators to be active	.098	.598	.183	.210
Motivators to be sedentary	.023	.974	.187	.196
Another child motivates behavior	.074	.740	.211	.136

'No' is the reference category

Table 2: Coefficients of determination (R^2) for environmental factors as predictors of time in sedentary and active time after accounting for inter-individual variance.



Note: Solid line in middle of the plots represents the mean difference between criterion and comparison data; dotted lines in the middle represent the 95% *CI* of the mean difference; dotted lines at the edges of the plots represent the 1.96 *SD* of the mean difference

Figure 1: Bland-Altman plots of estimates of time spent in sedentary and active (MVPA) behaviour comparing Actigraph (criterion) and BEACHES (comparison) data.

it is important to note that BEACHES estimated more sedentary time than the Actigraphs. This is presumably because the derived PA categories for BEACHES were only sedentary and active time, while the Actigraph criterion measure had three categories (sedentary, LPA, MVPA). In this study, we categorized walking as moderate because age-adjusted metabolic equivalents (METS) of walking in children ranges from 3.23 to 3.49, which falls within moderate intensity PA [11]. Furthermore, children with CP have been shown to have higher energy expenditure during walking, supporting the classification of this activity as moderate in intensity. Nevertheless, future work is needed to verify the consistency in the estimates by BEACHES with criterion measures [12].

Consistent with previous studies of children without disabilities, the children with CP were much less active at home (their boarding school residence) than during school recess [7]. Additionally, among the environmental factors assessed by BEACHES, being outdoors was found to be a significant predictor of children's PA levels, after accounting for inter-individual variance [8]. The replication of these findings in this pilot study supports the use of BEACHES to study the PA of children with CP. However, further work is needed to verify these preliminary findings and examine PA-related environmental factors in a larger sample and to assess different home environments.

Study Limitations

This study was conducted in a residential school setting, thereby limiting generalizations to other home living environments. Nevertheless, this study aimed to examine the suitability of BEACHES for PA studies in school and residential settings, and the findings justify further application of the instrument in PA studies of children with CP. The small sample size also limits the strength of generalizations, and a larger sample in future studies should be used to verify the results. The findings do, however, suggest that BEACHES provides a viable methodology for assessing the PA and associated environmental conditions in children with CP in both school and residential settings.

Conclusions

This study suggests that BEACHES be considered as a valid measure of PA in school and residential settings for children with CP, especially by researchers interested in assessing contextual factors. Using BEACHES is particularly relevant in classroom and clinical settings, where PA monitoring is likely to be geared towards individualized teaching and therapy designs.

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