Clinical Application and Feasibility of Utilizing the PEDI-CAT to Assess Activity and Participation Among Children Receiving Physical Therapy Incorporating Hippotherapy

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Comments
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Clinical application and feasibility of utilizing the PEDI-CAT to assess activity and participation among children receiving physical therapy incorporating hippotherapy

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ABSTRACT

Background: Hippotherapy (HPOT) is a physical therapy (PT) treatment tool using equine movement to improve mobility for children with movement impairments. Although research suggests HPOT improves body structure and function, there is limited evidence regarding its impact on activity and participation outcomes in a clinical setting. The Pediatric Evaluation of Disability Inventory Computer Adaptive Test (PEDI-CAT) may be useful in HPOT settings to highlight changes in activity and participation.

Purpose: 1) Evaluate the PEDI-CAT’s sensitivity to changes in activity and participation among children receiving PT using HPOT; 2) determine feasibility of administering the PEDI-CAT in a HPOT setting; and 3) examine how PEDI-CAT scores influence clinical decision-making.

Methods: Participants (N = 34) were children who attended weekly PT using HPOT for 6 months. The PEDI-CAT was completed for all participants by a parent or caregiver at initial treatment (T1) and 6 months later (T2). A linear mixed effects model was used to evaluate changes in scores over time. Team meetings occurred monthly to discuss how PEDI-CAT scores impacted treatment.

Results: There were significant improvements across 3 PEDI-CAT domains between T1 and T2 for all children with small effect sizes and nonsignificant changes noted within two diagnostic subgroups with small-to-medium effect sizes. The PEDI-CAT was completed by all participants without interrupting treatment flow. PEDI-CAT score reports enriched therapist-client conversations increasing shared decision-making.

Conclusion: PTs who treat children using HPOT may feasibly use the PEDI-CAT to assess changes in activity level outcomes and to assist clinical decision-making.

Introduction

Strategically using horses’ movement in a rehabilitation setting can provide a critical combination of physical challenge and motivation to promote improved mobility in children with motor limitations. Hippotherapy (HPOT) refers to how physical therapy (PT), occupational therapy, and speech-language pathology professionals use the purposeful manipulation of equine (horse) movement as a therapy tool to engage sensory, neuromotor, and cognitive systems to promote functional outcomes (American Hippotherapy Association, 2019). Though much of HPOT treatment encourages rhythmic motor activation, there is also reason to expect it may improve children’s abilities to participate in typical daily activities (Hsieh et al., 2017). Activity (i.e. the execution of a task or action) and participation (i.e. involvement in a life situation) (World Health Organization, 2007) are key outcomes for children with functional movement impairments. Current conceptual frameworks such as the International Classification of Functioning, Disability, and Health [ICF] (Chan et al., 2009; World Health Organization, 2007); Guide to Physical Therapy Practice (American Physical Therapy Association, 2014); as well as national policies (e.g. Individuals with Disabilities Education Act, Americans with Disabilities Act) encourage physical therapists to focus on improvements in activity and participation (Goldstein, Cohn, and Coster, 2004).

Despite calls to focus on activity and participation research investigating HPOT commonly focuses on improvements in body structure, body function, and gait characteristics (Kwon et al., 2015; Zadnikar and...
Kastrin, 2011). HPOT is theorized to promote balance and ambulation by utilizing the three-dimensional, reciprocal movement of horses’ gait, which imparts pelvic movements to the child. These movements stimulate active postural control throughout the head, arms, and trunk that resemble the controlled movements required during independent ambulation (Koca and Ataseven, 2015). During a single treatment session, clients can experience upwards of 3000 repetitive balance challenges, making HPOT a consistent and repetitive treatment tool (Thompson, Ketcham, and Hall, 2014). Studies have documented improvements in: adductor muscle symmetry (McGibbon, Benda, Duncan, and Silkwood-Sherer, 2009); gait mechanics (McGee and Reese, 2009); sitting balance (Kang, Jung, and Yu, 2012); and postural control (Champagne and Dugas, 2010) following HPOT interventions. A systematic review of interventions for cerebral palsy concluded HPOT was highly effective for improving balance and symmetry, but weaker results were reported for improving self-care and function (Novak et al., 2020). This review highlighted a need for more evidence demonstrating activity and participation improvements following HPOT.

The Pediatric Evaluation of Disability Inventory Computer Adaptive Test (PEDI-CAT) is used to measure activity and participation outcomes (Thompson, Cech, Cahill, and Krzak, 2018) in children age 0–20 with a variety of diagnoses. It is used to evaluate children’s performance across 4 different domains: 1) Mobility (e.g. ambulation); 2) Daily Activities (e.g. dressing); 3) Social Cognitive (e.g. interaction); and 4) Responsibility (e.g. staying safe). The breadth of the PEDI-CAT domains suggests it is viable for assessing activity and participation outcomes of clients with many diagnoses and varying needs. For instance, cerebral palsy frequently presents with motor control challenges (Sadowska, Sarecka-Hujar, and Kopyta, 2020) whereas individuals with autism may exhibit greater difficulties in socio-emotional domains (Maenner et al., 2020) both of which are assessed in different PEDI-CAT domains. Researchers have used the PEDI-CAT to assess activity and participation for children who are: typically developing (Dumas et al., 2012); with cerebral palsy (Shore et al., 2019); with autism spectrum disorder and intellectual developmental disabilities (Kao et al., 2012); with spinal muscular atrophy (Pasternak et al., 2016); and with a wide variety of diagnoses encountered in a pediatric hospital (Dumas et al., 2015).

Practice-based research or translational research is a critical component of improving clinical practice, as there is the potential for a gap between the structured research environment and the challenges associated with clinical settings (Westfall, Mold, and Fagnan, 2007). A considerable amount of HPOT research is conducted in controlled environments among homogenous populations with a specific diagnosis such as: cerebral palsy (McGee and Reese, 2009; McGibbon, Benda, Duncan, and Silkwood-Sherer, 2009); multiple sclerosis (Gencheva, Ivanova, and Stefanova, 2015; Menezes et al., 2013); and autism (Ajzenman, Standeven, and Shurtleff, 2013; Srinivasan, Cavagnino, and Bhat, 2018). However, pediatric clinical settings often serve clients who have more varied diagnoses, or even more than one diagnosis. In addition, research studies of HPOT tend to investigate shorter intervention periods between 5 and 12 weeks (Cabiddu et al., 2016; Homem and Oliveira, 2015; Kim and Lee, 2014; Lindroth, Sullivan, and Silkwood-Sherer, 2015; Lucena-Antón, Rosety-Rodriguez, and Moral-Munoz, 2018; Rigby et al., 2017); whereas clinic-based PT interventions in research settings may last up to 40 weeks (Academy of Pediatric Physical Therapy, 2012), and PT using HPOT commonly serves children with lifelong disabilities (Maresca et al., 2020; Wood and Fields, 2021). Therefore, it is necessary to examine changes in activity and participation outcomes with a validated assessment tool in the clinical environment and over a longer period to best reflect the effectiveness of PT treatment using HPOT and assist PT decision-making. The purpose of this study is to: 1) evaluate the PEDI-CAT’s sensitivity to changes in activity and participation among children receiving PT using HPOT; 2) evaluate the feasibility of PEDI-CAT use in a clinical environment that provides PT using HPOT; and 3) examine if PTs find PEDI-CAT scores useful when making clinical decisions. We hypothesized that the PEDI-CAT will be sensitive to changes in activity and participation outcomes across 6 months among a diverse client population receiving HPOT. It is further hypothesized that participants with cerebral palsy and autism will exhibit different amounts of change across PEDI-CAT domains. It is also hypothesized the PEDI-CAT will be feasibly incorporated into treatment, such that parents will consistently complete the PEDI-CAT during 1 treatment session without therapist assistance. Finally, PEDI-CAT scores are likely to aid clinical decision-making and stimulate collaboration between parent and clinician.
Methods

Data used in this study were collected by clinicians prior to creation of a formal study protocol, as data collection initially began as an effort by PT’s to systematically evaluate the effectiveness of their treatments. In pursuit of these aims, the clinicians began implementing the PEDI-CAT assessment with all pediatric PT clients, regardless of age or diagnosis, to assess best practices within a clinic that uses HPOT. This retrospective study was approved by Chapman University International Review Board, FWA# 00011020.

Participants

Data were collected from parents or caregivers of children (N = 34) receiving HPOT treatment at a multidisciplinary therapy center from October 2015 to April 2018. Parents or caregivers that completed the PEDI-CAT were all female and all fluent in English as their primary language. Thirty-three were mothers of participants and 1 was a fulltime caregiver who was the primary caretaker. See Table 1 for a description of participants including age, gender, diagnoses, and attendance rate. Children were included in this translational application if they: 1) were between 18 months-21 years; 2) new or ongoing clients to PT using HPOT; 3) had a documented functional movement impairment; and 4) were deemed able and safe to participate in HPOT treatment by therapists. Children were excluded if they: 1) had excessive therapy absences (i.e. absent ≥ 35% of treatments); 2) had uncontrolled seizures; or 3) discontinued therapy treatment within 6 months.

Measures

The PEDI-CAT was used to assess changes across four domains of activity- and participation-related outcomes. The measure has been found to have sound psychometric properties with: high test-retest reliability (Dumas et al., 2012); established content validity (Dumas, Fragala-Pinkham, Rosen, and Ni, 2021; Haley et al., 2012); and was responsive to change over time for children discharged from a pediatric rehabilitation hospital (Fragala-Pinkham, Dumas, Lombard, and O’Brien, 2016) and for children with CP (Kenyon et al., 2016). Scaled scores were examined in this study as they are most useful for tracking within-person change over time (Haley et al., 2012). Higher scores on the PEDI-CAT’s 20-80 scale are indicative of greater functional ability. Two versions of the PEDI-CAT were attempted in this study: 1) content-balanced; and 2) speedy. The content-balanced version displays approximately 30 items relevant to each domain (120 items total), whereas the speedy version displays up to 15 items relevant to each domain (< 60 items). Responses between the 2 versions tend to be highly correlated (Haley et al., 2012). Both the speedy and content-balanced versions of the PEDI-CAT are adaptive in that respondents see a minimum number of relevant items in each domain, but items displayed vary depending on prior responses, based on Item Response Theory modeling (Dumas, Fragala-Pinkham, Rosen, and Ni, 2021). The PEDI-CAT autism spectrum disorders module was not used in this study.

Feasibility data were collected by the PTs who administered the PEDI-CAT. Each PT noted: 1) if parents or caregivers completed the assessment within a single 45-min treatment session; 2) if the parent or caregiver encountered difficulties with iPad navigation; 3) if the parent or caregiver was or was not willing to participate in PEDI-CAT assessment; and 4) if the assessment interrupted PT intervention. PTs reported their feasibility data findings at monthly team meetings. In addition to feasibility evaluated by each PT, the primary investigator kept record of overall costs which included: 1) cost of the iPad; 2) PEDI-CAT

Table 1. Descriptive statistics for child participants.

<table>
<thead>
<tr>
<th>Total Participants</th>
<th>34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>18 female, 16 male</td>
</tr>
<tr>
<td>Mean Age (SD)</td>
<td>4.9 (2.0) 1.9–7.5</td>
</tr>
<tr>
<td>All Participants</td>
<td>4.8 (2.5) 1.9–11.8</td>
</tr>
<tr>
<td>All Participants</td>
<td>5.4 (2.5) 2.4–12.3</td>
</tr>
<tr>
<td>Cerebral Palsy</td>
<td>4.9 (2.0) 1.9–7.5</td>
</tr>
<tr>
<td>Cerebral Palsy</td>
<td>5.5 (2.0) 2.5–8.2</td>
</tr>
<tr>
<td>Autism</td>
<td>3.9 (1.5) 1.9–6.6</td>
</tr>
<tr>
<td>Autism</td>
<td>4.5 (1.5) 2.4–7.1</td>
</tr>
<tr>
<td>Diagnoses</td>
<td>10</td>
</tr>
<tr>
<td>Cerebral Palsy</td>
<td>9</td>
</tr>
<tr>
<td>Other Genetic Syndrome</td>
<td>5</td>
</tr>
<tr>
<td>Spina Bifida</td>
<td>2</td>
</tr>
<tr>
<td>Ehler-Danlos Syndrome</td>
<td>2</td>
</tr>
<tr>
<td>Angelman Syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Cancer</td>
<td>1</td>
</tr>
<tr>
<td>Developmental Delay</td>
<td>1</td>
</tr>
<tr>
<td>Down Syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Stroke</td>
<td>1</td>
</tr>
<tr>
<td>Traumatic Brain Injury</td>
<td>1</td>
</tr>
<tr>
<td>Client Status</td>
<td>25</td>
</tr>
<tr>
<td>New</td>
<td>9</td>
</tr>
<tr>
<td>Ongoing</td>
<td>23</td>
</tr>
<tr>
<td>Attendance rate</td>
<td>85% (68%-100%)</td>
</tr>
</tbody>
</table>
application fee; and 3) cost of training time for each therapist. All these factors were indicators of PEDI-CAT feasibility.

A translational team was assembled to evaluate the clinical application of the PEDI-CAT. Team members included five PTs, 1 PT assistant, 1 administrator, 1 statistician/psychologist, and 1 translational researcher/PT. The team collaborated via formal, once-per-month team meetings with notes taken by the translational researcher/PT. The primary investigator crafted and then proposed questions to the PTs regarding their use of the PEDI-CAT, both in these meetings and via e-mail after data collection (Appendix).

**Procedure**

Before the study began, therapists had varying levels of experience using the PEDI-CAT from none to a great deal. An in-person training session was provided by the primary investigator for each therapist on use of the PEDI-CAT App, interpretation of scores, and navigation of the iPad. Therapists demonstrated proficiency in all areas listed above by providing a practice test to the primary investigator who assessed individual performance. On-going support was provided by the trainer throughout the data collection.

Parents or caregivers completed an initial PEDI-CAT assessment, via iPad PEDI-CAT application, for their child at initial treatment (T1). Parents or caregivers completed a second PEDI-CAT assessment following 6 months of PT treatment (T2). The same parent or caregiver who completed the assessment at T1 also completed the assessment at T2 for each child. Respondents were directed to fill out the PEDI-CAT assessment while their child participated in PT. They were encouraged to respond as accurately as possible with the child’s most recent performance of activities in mind for each question. All data used in this study were collected using the speedy version of the PEDI-CAT.

After T1 data collection, children participated in 6 months of weekly PT using HPOT. Children were not restricted from participating in other therapies and activities outside of PT. Intervention protocol was semi-structured and included a minimum of 30 minutes astride the horse. Treating therapists included five PTs and 1PTA with a range of experience from 2 to 20 years using HPOT. Treatment was tailored to participants’ needs by selecting horses with varying movement qualities as well as individualized equipment. While astride the horse, participants engaged in developmentally challenging games and activities to work toward functional goals. Following 30 minutes on the horse, participants performed various ground- and clinic-based activities to further practice skills they worked on while astride the horse for a total treatment time of 45 minutes. This protocol could be considered usual care.

Therapists who provided PT using HPOT and who administered the PEDI-CAT were directed to discuss results of the PEDI-CAT with participants’ parent or caregiver via printed or on-screen score reports including lists of individual item responses, item maps, scaled scores, and percentile ranks within each domain. Therapists explained the meaning of scores at T1 and T2, as well as any changes in scores between T1 and T2, to each parent or caregiver. PTs reported about how discussions with parents or caregivers influenced clinical decision-making at the monthly team meetings.

**Data analysis**

Data were analyzed using “The R Project” statistical software version 3.5.3 (https://www.r-project.org/). A linear mixed effects model was used to assess if changes in scaled scores were significant in each functional domain (i.e. Mobility, Daily Activities, Social Cognitive, and Responsibility). Use of the linear mixed effects model allowed analysis of both fixed (i.e. time) and random (i.e. variability of initial scores) variables entered into subsequent linear equations in a stepwise manner. The first model eliminated variability due to heterogeneity of individual participants scores and was used to compare with subsequent linear models. The second model eliminated variability due to age of the participant. Subsequent predictors were added one at a time to determine if the addition of a predictor statistically improved the subsequent model. The scaled scores in each functional domain were used as dependent variables. Independent variables added to the model following the initial two models accounted for: assessment time (T1 and T2); number of treatments; the therapy status (i.e. whether they were a new, ongoing, or returning client); and the interaction of age and assessment. Cohen’s d effect sizes were calculated and adjusted for a sample size of < 50 and were used to examine the magnitude of differences (Durlak, 2009). A Bonferroni correction was used to control for type I error due to four significance tests with α = 0.05 divided by 4 analyses with a p-value of ≤ 0.0125 considered significant. The final linear mixed effects model utilized for this analysis was: $Y_{ij} = \beta_0 + \beta_1^{**age_i} + \beta_2^{*assessment_{ij}} + \beta_3^{*treatments_i} + \beta_4^{*status_i} + \beta_5^{*age_i} \times assessment_{ij} + b_i + \epsilon_{ij}$.
where $Y_{ij}$ represents the PEDI-CAT domain standard score for $i$th individual for the $j$th assessment, with $b_i$ as the random effect for individual $i$; $\text{age}_i$ refers to the age at T1 for individual $i$, $\text{assessment}_{ij}$ indicates which assessment ($j$) being either T1 and T2 approximately 6 months later for the $i$th individual; $\text{treatments}$ is the number of treatments the child had between T1 and T2, $\text{status}$ refers to whether they were an ongoing, returning, or new client at the time of T1, and $\text{age} \times \text{assessment}_{ij}$ is the interaction of the child’s initial age and the assessment. The general intercept is represented by $\beta_0$, and $\beta_{1,5}$ represent the coefficients for the different variables and $\varepsilon_{ij}$ is the error term. Models were built with the variables using the “lmer” function in the “lme4” package (Bates, Mächler, Bolker, and Walker, 2015). Subsequent linear models were compared using a likelihood ratio test. See Table 2 for specific models, which reached significance. We excluded Responsibility domain data for participants younger than 3 years of age ($n = 11$), in line with recommendations from the PEDI-CAT administration manual (Haley et al., 2012). Linear mixed effect models were not calculated for the subset with cerebral palsy ($n = 10$) or the subset with autism ($n = 9$) secondary to the small number of participants, therefore, mean differences and effect sizes of these differences were calculated and reported.

Feasibility measures were comprised of count data and costs by analyzing monthly team meeting notes and reviewing receipts. The count data included: 1) number of parents or caregivers who were able to complete the PEDI-CAT within one 45-min session; 2) number who encountered device issues; 3) number who were willing to participate; and 4) time therapists spent during treatment to administer the PEDI-CAT. Cost data were tallied and included: 1) cost of iPad; 2) PEDI-CAT application fee; and 3) cost of therapist training. An aggregate of these data was then calculated to represent overall cost of PEDI-CAT implementation.

Answers to open-ended questions regarding the impact of PEDI-CAT scores on clinical decision-making from team meeting notes and e-mail survey questions were coded and analyzed by one investigator. Concepts in the data were recorded as themes if they were mentioned by more than 50% of PTs. Proposed themes were then presented to the research team to engage in consensus building. Themes were only reported if there was unanimous consensus among all team members. This was done to best represent the multitude of backgrounds and experiences that are representative of a typical pediatric PT clinic.

### Results

**PEDI-CAT sensitivity to change**

When examining the results of the linear mixed effects models, initial age and time were the only variables that improved subsequent models. $\chi^2$-values and $p$-values for model improvement (i.e. age and time only) are reported in Table 2. The addition of initial age improved the model for all domains except Mobility. The addition of time improved the model for all domains except Responsibility.

Small effect size improvements were observed for three domains, which demonstrated significance over time (i.e. Mobility, Social Cognitive, and Daily Activities). Mean changes, effect sizes with 95% confidence intervals are presented in Table 3. The two largest diagnostic subset groups within the sample, autism, and cerebral palsy, showed greatest improvements from T1 to T2 in different domains. The autism subgroup improved the most in the Daily Activities domain with a medium effect size, whereas the cerebral palsy subgroup improved the most in the Social Cognitive domain with a small effect size. Violin plots (Figure 1a,b) reflect the distribution of the scores within each PEDI-CAT domain. These plots provide visual comparison of the changes observed within the sample and subgroups between T1 and T2. The violin plots generally shifted upward from T1 to T2, either as an entire figure or due to upward mobility of individual scores within the plot affecting the width of the plot. These figures also show that participants were

| Table 2. Significant results of likelihood ratios for linear mixed effects models. |
|----------------------------------------|-----------|-----------|
| Model                                  | Mobility  | $\chi^2_{(2)}$ | $p$ value |
| 1 Participant variability               | Mobility  | 5.48      | 0.019 |
| 2 Participant variability + initial age | Mobility  | 20.97     | < 0.001* |
| 3 Participant variability + initial age + time | Mobility | 15.34     | < 0.001* |
| 1 Participant variability               | Social/Cognitive | 22.36     | < 0.001* |
| 2 Participant variability + initial age | Social/Cognitive | 12.15     | < 0.001* |
| 3 Participant variability + initial age + time | Social/Cognitive | 14.63     | < 0.001* |
| 1 Participant variability               | Daily Activities | 15.12     | < 0.001* |
| 2 Participant variability + initial age | Daily Activities | 16.12     | 0.025 |
| 3 Participant variability + initial age + time | Daily Activities | 5.08     | 0.132 |

Bonferroni-adjusted value used for significance was: *$p < .0125$. Additional independent variables did not significantly improve the model and are not reported in table.
### Table 3. PEDI-CAT scaled scores for time 1 and time 2.

<table>
<thead>
<tr>
<th></th>
<th>Mobility</th>
<th>Social Cognitive</th>
<th>Daily Activities</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Participants</td>
<td>(N = 34)</td>
<td>(N = 34)</td>
<td>(N = 34)</td>
<td>(n = 23)</td>
</tr>
<tr>
<td>T1 Mean (SD)</td>
<td>59.0 (5.8)</td>
<td>58.9 (6.1)</td>
<td>50.2 (4.9)</td>
<td>41.2 (6.6)</td>
</tr>
<tr>
<td>T2 Mean (SD)</td>
<td>60.8 (5.8)</td>
<td>60.4 (5.5)</td>
<td>51.6 (4.9)</td>
<td>42.5 (7.8)</td>
</tr>
<tr>
<td>Mean Change</td>
<td>1.8*</td>
<td>1.5*</td>
<td>1.4*</td>
<td>1.3</td>
</tr>
<tr>
<td>Cohen’s d</td>
<td>0.30</td>
<td>0.25</td>
<td>0.27</td>
<td>0.18</td>
</tr>
<tr>
<td>Cohen’s d 95% CI</td>
<td>(−0.20, 0.72)</td>
<td>(−0.23, 0.75)</td>
<td>(−0.42, 0.78)</td>
<td>0.78</td>
</tr>
<tr>
<td>Cerebral Palsy</td>
<td>(n = 10)</td>
<td>(n = 10)</td>
<td>(n = 10)</td>
<td>(n = 7)</td>
</tr>
<tr>
<td>T1 Mean (SD)</td>
<td>56.1 (7.1)</td>
<td>58.4 (7.0)</td>
<td>49.7 (4.2)</td>
<td>41.7 (4.9)</td>
</tr>
<tr>
<td>T2 Mean (SD)</td>
<td>57.5 (7.2)</td>
<td>60.2 (5.6)</td>
<td>50.5 (4.1)</td>
<td>42.0 (5.5)</td>
</tr>
<tr>
<td>Mean Change</td>
<td>1.4</td>
<td>1.8</td>
<td>0.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Cohen’s d</td>
<td>0.18</td>
<td>0.26</td>
<td>0.18</td>
<td>0.05</td>
</tr>
<tr>
<td>Cohen’s d 95% CI</td>
<td>(−0.76, 1.12)</td>
<td>(−0.69, 1.20)</td>
<td>(−0.77, 1.12)</td>
<td>(−1.11, 1.22)</td>
</tr>
<tr>
<td>Autism</td>
<td>(n = 9)</td>
<td>(n = 9)</td>
<td>(n = 9)</td>
<td>(n = 6)</td>
</tr>
<tr>
<td>T1 Mean (SD)</td>
<td>61.3 (5.7)</td>
<td>57.9 (5.7)</td>
<td>49.3 (4.0)</td>
<td>38.2 (5.1)</td>
</tr>
<tr>
<td>T2 Mean (SD)</td>
<td>62.8 (4.7)</td>
<td>58.7 (5.0)</td>
<td>51.8 (3.8)</td>
<td>39.7 (7.2)</td>
</tr>
<tr>
<td>Mean Change</td>
<td>1.5</td>
<td>0.8</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Cohen’s d</td>
<td>0.26</td>
<td>0.14</td>
<td>0.58</td>
<td>0.20</td>
</tr>
<tr>
<td>Cohen’s d 95% CI</td>
<td>(−0.68, 1.20)</td>
<td>(−0.81, 1.10)</td>
<td>(−0.38, 1.54)</td>
<td>(−1.09, 1.49)</td>
</tr>
</tbody>
</table>

Bonferroni-adjusted value used for significance were: *p < .0125 (p-values reported in Table 2). Linear mixed effects models were not run for cerebral palsy and autism subgroups due to small sample size.

Clinicians unanimously agreed that information provided by PEDI-CAT assessments assisted with making clinical decisions and adjusting clients' therapeutic plan of care. Several themes emerged from discussions in team meetings, including: 1) all PTs stated that reviewing the PEDI-CAT score reports with clients' parents or caregivers enriched shared decision-making; 2) PEDI-CAT scores highlighted areas of need within specific domains, helping PTs write goals and tailor interventions to personalize their plan of care; and 3) PEDI-CAT scores provided PTs a unique parent-perspective regarding each child’s abilities that is not readily available via observational standardized assessments. One PT exemplified this saying: “The PEDI-CAT results were most useful at initial evaluation to help set goals and direct conversation with the parents regarding areas of need for PT treatment. Then when I had 2 assessments after 6 months of treatment, the PEDI-CAT scores were easy to compare across time and showed each child’s progress, as well as areas that continued to need improvement both between and within the various domains.”

### Discussion

Our results support positive outcomes for all three of our aims. First, the PEDI-CAT was sensitive to improvements over 6 months among children with varied movement disorders. When we broke out and examined the two largest subset groups in our sample, autism, and cerebral palsy, we found differences in areas of improvement, which appear to fit common limitations in each diagnosis (Accardo, 2007; Maenner et al., 2020). Secondly, the PEDI-CAT was feasibly implemented with low costs and was easily completed without interrupting treatment flow. Finally, therapists found PEDI-CAT scores were useful for fostering conversation with participants’ families, leading to increased, shared decision-making.
The PEDI-CAT was found to be sensitive to changes in activity, but not participation, for pediatric clients utilizing HPOT as part of PT. The Daily Activities domain of the assessment has been found to be sensitive to changes over time in a longitudinal study of children with cerebral palsy (Burgess et al., 2020) and was examined for sensitivity in a setting using HPOT for children with Autism (Peters, Wood, Hepburn, and Moody, 2021). Burgess et al. (2020) found that children with cerebral palsy demonstrated a range of estimated change in scaled score per year of 0.42 to 0.72 corresponding with our findings within the cerebral palsy subgroup who demonstrated a mean change of 0.8 over 6 months. Peters, Wood, Hepburn, and Moody (2021) used the PEDI-CAT to assess changes in all 4 domains for 18 children who participated in occupational therapy using hippotherapy but did not find statistically significant improvements over time. Their data show similar small-to-medium effect size changes compared to our autism subgroup.

Our study represents one of the first attempts to evaluate the sensitivity of the PEDI-CAT to changes over time in a HPOT setting. Our results suggest the PEDI-CAT is able to detect objective changes in activity. The average changes detected for the entire sample in this study ranged between 1.3 and 1.8 points. It should be noted these changes had small effect sizes and may not exceed the minimal clinically important change value (MCID) needed to represent clinically significant change (Cook, 2008). More research is necessary to establish MCID for

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**Figure 1** The violin plots above depict the distribution of PEDI-CAT scaled scores for Mobility and Daily Activities domains for all participants (N = 34), cerebral palsy subset (n = 10), and autism subset (n = 9). Assessment 1 and 2 refer to T1 and T2. Solid circles represent group means, and open circles represent individuals’ scores. A wider violin corresponds to a greater density of scores.
the PEDI-CAT in this setting. This sensitivity to changes in pediatric clients is important for two reasons. One, it provides objective activity and participation outcome data for a heterogeneous patient population. Two, the PEDI-CAT may be used to show progress over time for clients who participate in PT using HPOT. This information may be useful to convince insurance companies to value, recognize, and cover HPOT. Insurance coverage of PT using HPOT would have the added benefits of decreasing the financial burden of clients seeking PT using HPOT (Pham and Bitonte, 2016).

Improvements observed in different PEDI-CAT domains for the entire sample may be influenced by multiple factors including: bidirectional relationship of ICF levels; interrelationship between various facets of development; and the unknown impact of other activities and therapies participants may have been involved in during the study. The primary focus of PT using HPOT is to improve movement capabilities; therefore, it would be expected that the Mobility domain would increase over time for children receiving weekly PT. However, we found improvements in 3 out of 4 domains (i.e. Mobility, Daily Activities, and Social/Cognitive). These results may point to a positive cascade effect (Gonzalez, Alvarez, and Nelson, 2019; Iverson, 2010); that is as Mobility increases so does the ability to perform daily activities or social/cognitive tasks. This is in line with other research that shows improved mobility is positively correlated with higher levels of daily functional skills (Kwon et al., 2013) and cognitive skills (Muentener, Herrig, and Schulz, 2018). For example, as children improve mobility skills like independently walking with a walker rather than self-propelling a wheelchair they can then talk with peers eye to eye.

![Figure 1 b. The violin plots above depict the distribution of PEDI-CAT scaled scores for the Social Cognitive domain for all participants (N = 34), cerebral palsy subset (n = 10), and autism subset (n = 9) and Responsibility domain for all participants 3 years of age or older (N = 23), cerebral palsy subset (n = 7), and autism subset (n = 6). Assessment 1 and 2 refer to T1 and T2. Solid circles represent group means, and open circles represent individuals’ scores. A wider violin corresponds to a greater density of scores.](image-url)
(Social/Cognitive), or when they gain the ability to sit upright independently they can then put on a shirt (Daily Activity).

Responsibility scores did not significantly change across time. Responsibility domain activities (e.g. keeping track of time and following a recipe) are seldomly addressed in PT and may be more closely linked to how involved the parent or caregiver is in helping the child. The Responsibility domain of the PEDI-CAT is not recommended for children younger than 3 years of age (Haley et al., 2012). Eleven participants were younger than 3 years at T1 and were excluded from the analysis, which may partially explain why we did not find a significant change in Responsibility scores over time for the sample. Another possible explanation may be found in the differences of abilities between diagnostic groups within our sample. While the autism subgroup participants who were older than 3 ($n = 7$) showed a mean change of 1.5, the CP subgroup participants who were older than 3 ($n = 6$) had their lowest change in this category with a mean change of only 0.3.

Two important demographic factors appeared to play a role in PEDI-CAT outcomes across the different domains. For one, with age, children gain motor and social/cognitive skills and begin to take more responsibility. This was partially true of our sample, except initial age was not correlated with the Mobility domain. This is likely because PT focuses on treating mild to severe movement impairments across all ages, which may attenuate an age-impairment relationship. Additionally, varying diagnoses pose unique developmental challenges affecting activity and participation improvements. We found that participants with cerebral palsy showed the greatest improvement in the Social Cognitive domain ($d = 0.26$), whereas participants with autism showed the greatest improvement in the Daily Activities domain ($d = 0.58$). This supports the research showing beneficial effects of HPOT for children with cerebral palsy (Novak et al., 2020) and autism (Srinivasan, Cavagnino, and Bhat, 2018); however, our data cannot explain why improvements were made in specific domains over others for these participants. This would be an interesting avenue for future research.

The PEDI-CAT was selected not only because of its ease of use in the clinical environment and reporting capabilities, but also for its cost-effectiveness and scalability as well as data collected. This assessment was especially clinically relevant because it was easily administered and incorporated within each pediatric clients’ plan of care regardless of age or diagnosis. All participants were able to complete the Speedy version of the PEDI-CAT within a single treatment session, which is in line with another study that reported all 4 domains were completed in an average time of 12 minutes (Dumas et al., 2012). It was noted to cost less than $4,000 for unlimited PEDI-CAT tests and 2 iPads that are also used for many relevant clinical applications such as video movement analysis, e-mail, and client education via anatomical diagrams. These costs represent a one-time setup fee for indefinite use of the PEDI-CAT assessment tool as well as the many other beneficial clinical uses of the iPads.

Individual PEDI-CAT score reports provided PTs with valuable data that informed clinical decisions. PTs were able to compare within individual reports, from initial assessment to 6 months later, to guide conversation between parent or caregiver and clinician and engage in shared, informed decision-making. If a client’s scores improved more than 2 times the standard error for a given domain, then PTs could be more certain that the outcome represented a real change in activity or participation. The PEDI-CAT score reports gave PTs and parents or caregivers a common language to discuss functional changes each child exhibited and guided the team to assess more specific areas of clients’ needs. Studies show that increasing communication between client and clinician leads to improved outcomes (Hargraves, LeBlanc, Shah, and Montori, 2016; Stiggelbout et al., 2012). PT’s in this study reported that this process often led to greater therapeutic rapport and mutual understanding.

An example of shared decision-making between PT and a participant’s parent comes from an 8-year-old girl, who was non-verbal, had behavioral challenges, and difficulty following directions. Her mother stated there was marked variability between the skills she demonstrated spontaneously at home and those she displayed upon request during treatment. The PEDI-CAT assessment allowed the therapist to capture the parent’s perspective of the child’s participation at home, as the mother was able to share about her child’s performance of activities, such as stair climbing or opening jars. Repeating the PEDI-CAT 6 months later revealed improved Mobility scaled scores from 61 to 65, as well as improved Daily Activities scaled scores from 52 to 54. The changes in Mobility scores likely represent changes beyond measurement error, as the 95% CIs of SE at Time 1 (59.20, 62.80) and Time 2 (63.58, 66.42) do not overlap. The changes in Daily Activities scores showed improvements but were slightly less likely to represent changes beyond measurement error, as only the 77% CIs of SE at Time 1 (51.05, 52.95) and Time 2 (52.99, 55.01) do not overlap. The parent and therapist discussed the improvement in scores as the therapist was not seeing her skills improve in clinical observations.
The parent relayed marked improvements in her child’s abilities at home that correlated with PEDI-CAT scores representing actual functional change. The PT then tailored treatment goals to address areas of concern related to home and community performance and extended her PT plan of care.

A close examination of the HPOT process reveals why it may be particularly effective at treating not only body structure and body function impairments, but also activity limitations and participation restrictions of the ICF model (Chan et al., 2009). Although the activity and participation outcome improvements we observed cannot be attributed to HPOT alone, these results are in line with recent HPOT theoretical reasoning (Koca and Ataseven, 2015). HPOT effectively masks a high active workload, via enjoyable activities and changing environment, allowing increased repetition of motor skill practice. This repetition likely leads to solidifying motor skill acquisition (Merbah and Meulemans, 2011) to improve activity and participation reflected in PEDI-CAT scores. Activity and Participation skills commonly require dual-task abilities for independent completion (Huang and Mercer, 2001). Clients astride a walking horse frequently perform dual tasks by maintaining their balance while simultaneously reaching for objects, scanning their environment, and engaging with the therapist. This dual-task practice helps build automaticity of performance of certain tasks, as the unique challenges astride the horse may help generalize motor learning to other environments.

There are a few limitations to note about this study. Although we observed positive changes in activity following PT using HPOT, we lacked a control group and children were simultaneously involved in other therapies and activities reducing the confidence that these improvements were due solely to the use of HPOT. Participant data were collected at a single site limiting the sample size. This study did not incorporate a standardized treatment protocol—it required only that the horses’ movement be used for a minimum of 30 minutes per treatment session; however, PTs who provided HPOT were highly trained and provided similar treatments due to frequent collaboration. We chose not to include specialized PEDI-CAT modules (e.g. the PEDI-CAT with ASD scales) in the present study to specifically assess the feasibility of using a single assessment across a wide variety of diagnoses; however, it is notable that incorporating diagnosis-specific PEDI-CAT modules could produce more valid data for understanding children’s changes or improve interpretability of scaled scores by using module-specific referents. When paired with other traditional clinical methods, therapists can adjust HPOT application to address the individual needs of each child. Therefore, the application of HPOT in this study closely reflects how it is commonly implemented within clinical settings.

This study provides a foundation for future research on the incorporation of the PEDI-CAT as an assessment tool and its application in clinical settings, including those using HPOT. PTs feasibly used the PEDI-CAT to assess activity outcomes for children who received PT using HPOT with varying ages and diagnoses. It was cost-effective, easy to administer, and encouraged collaboration between clinician and caregiver to provide improved shared, clinical decision-making. Currently, our team is implementing a multi-site data collection effort to examine changes in PEDI-CAT outcomes for a larger, more geographically diverse sample. This effort will include PT, occupational therapy, and speech therapy using HPOT. This will allow more robust examination of the effectiveness of the PEDI-CAT to track changes in activity and participation outcomes among all professions that use HPOT.

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References


Pham C 2016 Bitonte R hippotherapy: Remuneration issues impair the offering of this therapeutic strategy at Southern California rehabilitation centers. Neurological Rehabilitation 38: 411–417.


Appendix – Questions to the PTs regarding their use of the PEDI-CAT

The following questions guided discussions between the primary investigator and the 5 participating therapists during once-per-month translational team meetings. Questions appear in no specific order.

- In what ways did using the PEDI-CAT impact your treatment plan?
- How did you share results of the PEDI-CAT with your clients’ families?
- What information did the PEDI-CAT results provide that you may not have known without it?
- Did the PEDI-CAT reveal any skills or areas of need that you did not see in clinical observation? If so, please explain.
- How do you describe each domain to your clients’ caregivers?
- How did the participants’ parents or caregivers respond when presented with PEDI-CAT results?
- How did you use the PEDI-CAT to help evaluate treatment frequency or discharge planning?
- Were any of your clients’ caregivers unable to complete the PEDI-CAT due to technical difficulties? If so, please explain.
- How closely do caregiver answers to each survey item match what you see in your clinical observations?
- How did you use PEDI-CAT results to help write your goals for your clients?