

Clinical pain research

Physical and occupational therapy outcomes: Adolescents' change in functional abilities using objective measures and self-report[☆]Heidi Kempert^{a,*}, Ethan Benore^b, Rachel Heines^a^a Cleveland Clinic Children's Hospital for Rehabilitation, Therapy Services Department, United States^b Center for Pediatric Behavioral Health, United States

H I G H L I G H T S

- Measures of adolescent physical functioning during pain rehabilitation are needed.
- Subjective measures capture change in functioning and perceived ability.
- Additional objective measures enhance monitoring of functioning.
- Functional changes in pediatric pain rehabilitation are independent of pain scores.

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A B S T R A C T

Purpose: This study evaluates the clinical usefulness of patient-rated and objective measures to identify physically-oriented functional changes after an intensive chronic pain program in a pediatric setting. Past studies have demonstrated the importance of adolescents' perception of their abilities and measurement tools used for rehabilitation outcomes within physical and occupational therapy; however, these tools used are not often easily utilized or have not been examined with a pediatric chronic pain population. In chronic pain rehabilitation, it is important to have a primary focus on functional improvement not on pain reduction as a leading outcome. This study examines how both self-report and objective physical activity measures can be meaningful constructs and can be used as reliable outcome measures. It was hypothesized that adolescents completing an interdisciplinary pain rehabilitation program would report functional gains from admission to discharge, and that perceived gains in physical ability would be associated with objective physical activities. Further, it was hypothesized that gains in functioning would be associated with mild pain reduction.

Methods: Data from 78 children and adolescents with chronic pain that participated in an intensive multidisciplinary treatment program completed self-report measures including the Lower Extremity Functional Scale (LEFS), Upper Extremity Functional Index (UEFI). In addition, adolescents were objectively monitored for repetitions of selected physical activities for 1 min intervals.

Results: Data demonstrated significant gains in all measures of functioning during the program. Correlations between self-report and objective outcomes suggest they are measuring similar yet distinct factors.

Conclusions: The LEFS, UEFI, and objective exercises provide a meaningful way to track progress in pediatric chronic pain rehabilitation. Despite similarities, they appear to track separate but related aspects of rehabilitation and capture important short-term response to rehabilitation. Both measures appear distinct from pain as an outcome. These findings increase our understanding of rehabilitation practices provide opportunities to promote clinical improvement in pediatric pain.

Implications: The use of self-report measures along with objective measures can help therapists gain understanding in regards to a patient's insight and how that may impact their overall outcome compared to the use of a single outcome measure. Viewing these rated measures at any point in the rehabilitation process can be useful to facilitate discussion about challenges they can identify and how therapies can facilitate improvement and functional gains.

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1. Introduction

1.1. Background

Pediatric chronic pain is on the rise, affecting up to 40% of adolescents, causing significant functional impairments (5–10%) [1–4]. Adolescents with chronic pain often struggle with every day activities, family interactions, participation in sports or leisure activities, and consistent school attendance. As a result, many begin to experience worsened self-perceived health status [5,6], including their perception and ability to complete physical tasks.

An interdisciplinary rehabilitation approach is a useful model of care for adolescents severely affected by chronic pain and functional disability [5,7–10]. Given the nature of chronic pain, dramatic reduction in pain is not anticipated or targeted as an early outcome to intervention. Rather, treatment aims to increase independent symptom management and improved daily functioning [2,11]. Research supports education and participation in physical activity/exercise can reduce pain and limit disability [12]; therefore daily physical, occupational, and recreational therapies are a necessary part of rehabilitation. Therapy goals for adolescents with chronic pain are to improve independent, consistent daily physical functioning, and to reduce sedentary habits and activity avoidance.

Due to a global sense of impairment and lack of insight, many adolescents who experience chronic pain often perceive that they are limited in daily functional tasks and basic physical activity [7,13]. For this reason, gains in therapy physical functioning should be measured with both self-report and objective measures. Self-report tools help track perceived functional gains and demonstrate the psychological aspects of independent functioning. Objective measures can enhance assessment of functional gains by isolating the psychological aspects of perceived confidence.

There is limited research supporting specific outcome measures for adolescents with chronic pain in rehabilitation, specifically targeting physical or occupational therapy interventions. Commonly used therapeutic objective measures and assessments include the BOT [14], GMFM [15], and TUG [16]. Although helpful, these standardized tests can be time consuming, require additional resources, and be limited by areas of functioning or age ranges. Other standardized physical measures exist for high level athletes (PACER test, shuttle run, etc. [17]), but are less ideal in deconditioned adolescents. Few easily administered and appropriate objective measures exist for evaluating and tracking physical function for adolescents with chronic pain.

There exists a need for easily administered self-report and objective measures to examine adolescent functioning and change in functioning following chronic pain rehabilitation. Past research suggests the utility of self-report measures, but the utility of objective measures and their relation to self-report measures remain unknown.

1.2. Hypothesis

This study examines the use of two self-report measures and 5 objective fitness exercises to track physically oriented functional gains within a pediatric chronic pain rehabilitation program. Hypotheses include:

- Adolescents completing a multidisciplinary pain rehabilitation program, which targets physical functioning, will report perceived functional gains from admission to discharge.
- Adolescents will similarly demonstrate improvements in objective measures as they do in their rating of perceived functional gains.

- Self-report and objective measures will correlate at both admission and discharge.
- While we do not expect a large decrease in pain during rehabilitation, we anticipate that adolescents who report or demonstrate gains in physical ability will also demonstrate a mild reduction in reported pain intensity.

2. Methods

2.1. Participants

116 Children and adolescents (hereafter referred to as adolescents) ranging in age from 8–19 years old, with varying chronic pain diagnoses, were treated in this chronic pain rehabilitation program. Data for this study was collected retrospectively on all program participants. The most common diagnoses include headaches and migraines, back pain, abdominal pain, amplified musculoskeletal pain syndrome (AMPS) and complex regional pain syndrome (CRPS) (Fig. 1). Adolescents were excluded from data analysis if they: opted out of specific treatment, left the program early, withdrew consent, incomplete data forms, or participation in the program was extended past the typical 3–4 weeks (38 adolescents). Data of both self-report and objective measures for 78 adolescents was reported.

2.2. Program/procedure

Chronic pain rehabilitation on a multidisciplinary level focuses on improved strength and endurance, facilitating return to daily life activities, and using appropriate self-directed coping and pain management skills [5–7]. Participants were typically seen for three weeks including both inpatient and day hospital care for full days. Within the program, adolescents participated in rehabilitation therapies, psychological services, medical subspecialty care, alternative therapies, and school services. Since an adolescent is part of a family unit, parents were also involved in education and observations with providers to help them support continued progress once home [6].

The goal of chronic pain rehabilitation has evolved from eliminating pain to managing pain so that overall functioning is

Percentage of Cases by Diagnosis

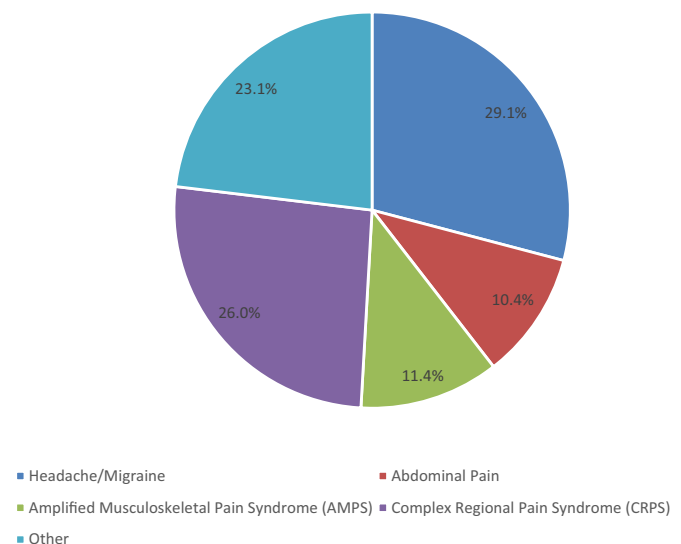


Fig. 1. Percentage of cases by diagnosis.

improved. Progress is measured in part by physical functioning despite continuation of pain and symptoms [7].

2.3. Physical and occupational therapy treatment

Physical and occupational therapies were completed in both group and individual sessions for 3–4 h daily in land and pool settings. In therapy sessions, adolescents worked on isolated strengthening of appropriate musculature, endurance, proprioceptive and sensory training techniques, and other exercises or skills to help each adolescent return to highest level of function necessary. All adolescents spent time working on individual goal-oriented activities and independence with strengthening and endurance tasks while focusing on improved body mechanics and posture during exercises [6]. Limited time was spent on passive therapeutic interventions (e.g., massage, micro current, TENS), as the goal of therapies is to promote independence [18]. Parents were included for weekly education on therapeutic activities, barriers to improved function, appropriate modifications and accommodations, and expectations for going home [6]. At times, this included parents being more hands-on, working on behavioral planning, and observing an increased number of sessions. At a clinical level, improvements were measured by meeting specific therapy goals relating to improvements with presenting impairments, functional limitations or restrictions [19] (e.g., walking 100 yards without a walker/cane or tolerating a daily stretching and exercise regimen without pain complaints).

2.4. Measures

The reported data was collected upon the day of admission and at the day of discharge and retrospectively reviewed. Data collection through REDCap has been approved by the Institutional Review Board and is on the clinical database registry [20].

2.5. Lower Extremity Functioning Scale (LEFS) and Upper Extremity Functioning Index (UEFI)

Self-report tools have been useful to track perceived functional gains and demonstrate the psychological aspects of independent functioning. The Lower Extremity Functional Scale (LEFS) [21] and the Upper Extremity Functional Index (UEFI) [22] are self-report measures that were developed because of the need for a simple outcome tool that could be used to track an individual's function level throughout the course of rehabilitation. Additional benefits to these measures that may not be realistic for other functional outcome measures include ease of administration, application to any musculoskeletal disorder, and generalizability to settings outside of the clinic or hospital. Both measures can be easily incorporated into individual or group treatment sessions, and are completed by the adolescent with guidance from a physical or occupational therapist [6]. Past research using these measures has demonstrated their utility as an outcome measure in pediatric pain rehabilitation [6].

The LEFS and UEFI are 20-item self-report measure about one's perceived ability to perform everyday tasks with lower extremities and upper extremities, respectively. Individuals rated each item on a 0–4 likert scale (0 = extreme difficulty or cannot perform and 4 = no difficulty). Scores were summed for a possible score of 0–80. The LEFS has demonstrated good internal consistency (Cronbach's $\alpha = .96$) as well as test-retest reliability ($r = .86$). The UEFI has demonstrated good internal consistency (Cronbach's $\alpha = .94$) as well as test-retest reliability ($r = .95$). Both scales are also sensitive to change in functioning—a minimum detectable change score of 9 points is considered clinically important [6,19,23].

2.6. Objective measures

Simplistic objective measures, such as activities used in nationally recognized fitness tests for school aged children (i.e., fitness gram test [24]), may effectively provide information on improvements in function. Therapists in this program have used consistent objective measures of function as part of clinical care. Some measures are used with typical developing peers within the school setting [18,23,25–28].

The objective measures used in programming for data collection included: push-ups, crunches, prone extension, step ups, and jump rope (number of repetitions during 60 s). The therapist kept track of time and provided prompting to improve alignment and body mechanics while the patient self-counted repetitions and logged them, as would be done in a school setting [24]. The ability for participants to self-count and track information is important as taking a more independent role in their progress can help promote long term gains [29]. Adolescents completed these activities in group setting and tracked these measures weekly throughout the program allowing for visualization of progress. The amount of repetitions for each exercise was recoded into an ordinal variable: zero, 1–5, 6–10, 11–20, 21–30, 31–40, 41+ reps. Admission and discharge data were recorded for this study.

2.7. Pain

A single-item measure evaluated pain severity rating in last 24 h using a numerical rating scale (NRS) from 0 (no pain) to 10 (worst pain) [19].

2.8. Analysis plan

This data was captured in a REDCap database [20], then converted to an SPSS 22.0 dataset for analyses. Paired *t*-tests evaluated change in self-report measures (LEFS, UEFI and pain) over time. Wilcoxon signed ranks tests evaluated change in objective performance on standard measures over time. Spearman correlation coefficients were calculated to evaluate the relationship between self-report ratings of functioning and objective performance measures at admission and discharge. In order to demonstrate the association between change in physical functioning and change in self-reported pain, a series of regression analyses were performed. First, baseline measures of LEFS, UEFI, objective measures and pain were entered to predict these same measures at discharge. Standardized residuals were retained to represent change scores. Next, residualized changes scores for LEFS, UEFI, and objective measures were entered to predict residualized change in pain in seven separate models.

3. Results

3.1. Participants

Out of the 116 adolescents enrolled in the study, 78 met inclusion criteria. There was no significant difference between patients included versus excluded in analysis on any demographic, diagnosis, or other major study variable. The average age was 15.1 years ($SD = 1.83$) and the majority (77%) were female, consistent with other research on this population. Adolescents had various diagnoses including headaches and migraines (29.1%), abdominal pain (10.4%), AMPs (11.4%) and CPRS (26%) as seen in Fig. 1. Other diagnoses included back pain, fibromyalgia, reflex neurovascular dystrophy, postural orthostatic tachycardia syndrome, foot pain, and Ehlers–Danlos syndrome. Most participants also presented with at least one other secondary pain diagnoses. The chronicity of pain was recorded as less than 6 months (13.5%), 6–12 months

Table 1

Group differences at baseline and discharge.

	Admission	Discharge	% Clinical change	Change statistic	p-Value
LEFS	43.1 (15.46)	59.2 (14.41)	70.5%	−9.080 ^a	<0.001
UEFI	56.2 (14.57)	68.1 (10.73)	55.1%	−8.439 ^a	<0.001
Push ups ^b				−6.576 ^b	<0.001
Crunches ^b				−5.842 ^b	<0.001
Prone extensions ^b				−5.622 ^b	<0.001
Step ups ^b				−6.786 ^b	<0.001
Jump rope ^b				−2.640 ^b	0.008
Pain	7.2 (2.15)	6.9 (2.29)		1.051 ^a	0.296
Pain 24	6.7 (2.09)	5.5 (3.41)		2.879 ^a	0.006

^a Paired t-test.^b Wilcoxon signed ranks test, see Fig. 2 for data distribution.

(18.8%), 12–18 months (10.4%), 18–24 months (13.5%), and almost half (43.8%) of the participants experienced chronic pain for more than 24 months.

3.2. Self-report data

Self-report data is presented in Table 1. Participants reported a statistically significant increase in lower extremity functioning ($t = -9.080$, $p < 0.001$) throughout rehabilitation. They also reported statistically significant increase in upper extremity functioning ($t = -8.439$, $p < 0.001$). Using criteria reported by scale developers, clinically significant increase in lower and upper extremities were identified in 70.5% and 55.1% of participants, respectively. Participants also reported a mild reduction in pain from 6.7 to 5.5 during rehabilitation ($t = 2.879$, $p = 0.006$). Secondary analysis evaluated whether functional improvements differed across clinical diagnosis; there were no significant differences in self-reports between diagnosis groups.

3.3. Objective data

Using objective measures of functioning revealed similar results. In Fig. 2 repetitions of standard exercises from admission and discharge data was reported. The median scores at admission were, respectively: push-ups (11–20), crunches (21–30), prone extensions (31–40), step ups (21–30), and jump rope (41+). The

median scores at discharge were, respectively: push-ups (31–40), crunches (41+) prone extensions (41+), step ups (31–40), and jump rope (41+). All scores were significantly improved across the three weeks of rehabilitation (Table 1). Wilcoxon signed ranks tests demonstrated significant change in all measures ($p < 0.001$, with the exception of prone extensions with $p = 0.008$).

3.4. Association between self-report and objective measures

Spearman correlations are listed on Table 2. Self-report measures (LEFS and UEFI) were significantly associated with most objective measures of functioning at baseline (sig. r 's ranged from .256 to .631). Correlations were slightly weaker at the discharge from the program (sig. r 's ranged from .224 to .399) with more non-significant associations. At both time points, self-report measures of functioning held stronger associations with self-report of pain, though again these associations were weaker at discharge.

3.5. Association between functioning and pain

Change in self-report measures of functioning did not significantly predict change in pain ratings during the 3-week rehabilitation program (Table 3). Change in self-reported functioning accounting for only approximately 3% of the variance in change in pain in both LEFS and UEFI (both F statistics nonsignificant). When evaluating objective measures, only change in jump

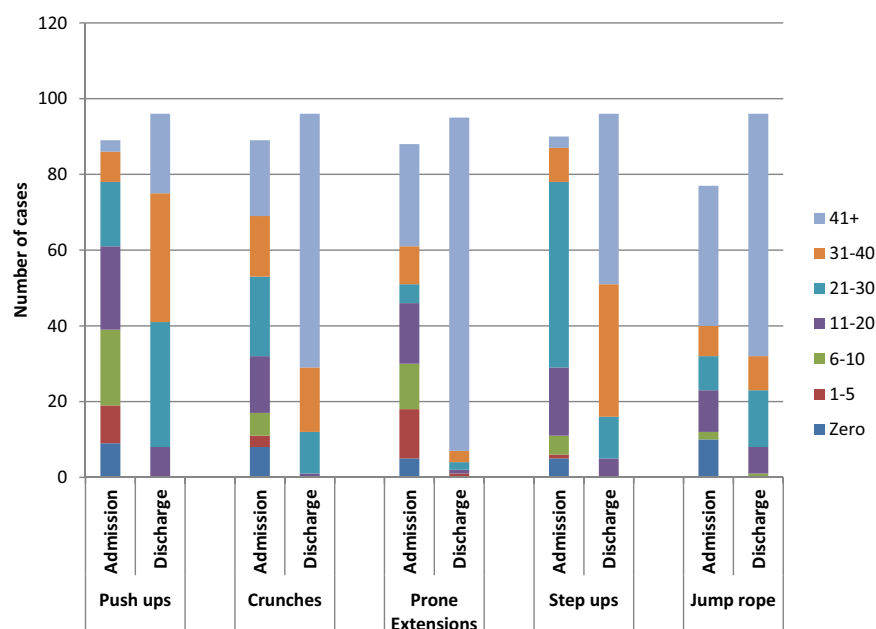


Fig. 2. Performance on objective measures of physical functioning for participants in pediatric chronic pain rehabilitation, at admission and discharge.

Table 2
Spearman correlations between major study variables.

	LEFS	UEFI	Push ups	Crunches	Prone extentions	Step ups	Jump rope	Pain
LEFS								
UEFI	.790***							
Push ups	.129	.091						
Crunches	.398***	.312**	.425***					
Prone extentions	.039	.080	.323**	.141				
Step ups	.399***	.224*	.317**	.138	-.003			
Jump rope	.338**	.261*	.146	.153	.212	.509***		
Pain	-.197	-.275*	-.080	-.048	.020	.011	-.219	

Unshaded region is admit data. Shaded region is discharge data.

* $p \leq 0.05$.

** $p \leq 0.01$.

*** $p \leq 0.001$.

Table 3
Change in functional measures predicting change in pain over 3 weeks.

	R^2	F-statistic	Standardized beta	p-Value
LEFS	.033	2.628	-.183	0.109
UEFI	.027	2.106	-.164	0.151
Push ups	.006	.398	-.080	0.531
Crunches	.001	.033	.023	0.856
Prone extensions	.001	.094	.038	0.760
Step ups	.001	.059	.030	0.808
Jump rope	.104	6.412	-2.532	0.014*

* $p \leq 0.05$.

ropes predicted change in pain. An increase in one's ability to jump rope predicted a reduction in pain over the three weeks ($F=6.412$, $p<0.05$). All other measures were non-significant, accounting for less than 1% of change in pain scores.

4. Discussion

Many studies demonstrate overall improvement following chronic pain rehabilitation [5,7,8,30], however less focus is paid on the combination of perceived physical functioning and objective abilities as an outcome. The primary goal of pediatric pain rehabilitation is to improve functioning despite pain and to limit activity avoidance. This study evaluated measures related to physical and occupational therapy components of programming.

4.1. Self-report

Data supported the hypothesis, and current efforts in rehabilitation [30], that adolescents would demonstrate statistically significant gains in both upper and lower extremity functioning following the program. More than half also report clinically significant gains in functioning over the 3 weeks of rehabilitation. Frequent practice of individualized functional tasks (i.e., simulation of school mobility, completion of house hold chores, and practice of leisure and recreation) during the program may lead to increased perception of physical functioning. This material can help demonstrate how self-report reflects ones sense of confidence and the importance of perceived outcomes on improving quality of life [7,13,30–32].

4.2. Objective measures

Patients also objectively demonstrated significant gains in functioning. Most patients demonstrated significant improvements in all 5 exercises from admission to discharge, completing higher repetitions at the end of the rehabilitation process as captured in Fig. 2. Not only can exercise intervals be used to track objective gains but are inherent to a rehabilitation process. Strength

training is an important component to the rehabilitation process to promote functional gains in patients with chronic pain [33]. It was highlighted by therapists that the adolescents should focus on alignment, breathing, efficient and coordinated use of muscle groups, and quality of movement instead of the specific quantity of repetitions. To this end, participants at times made less significant increases in repetitions counted due to improvements in overall body mechanics.

4.3. Correlation between all measures

Both self-report measures and objective measures are helpful outcomes for assessing physical functioning and in this specific study correlated at both admission and (to a lesser degree) discharge (Table 2). Objective data correlated at admission with self-report data and pain intensity. At discharge objective data partially correlated with self-report data, more specifically lower extremity measures compared to the upper extremity measures (Table 2).

Patients with higher self-reports of function completed a higher number of repetitions with objective tests, further validating the use of self-measurement as outcome variables. However, less significant correlations at discharge suggest these measures are distinct constructs, each adding unique value to understand patient and his/her response to rehabilitation. Self-rated and objective tools each have their strengths and together may show a more global picture of physical functioning from admission to discharge. These correlations also support that when perception and confidence in one's functional abilities was higher, the patient was able to participate at a higher level of activity. Higher correlations between UEFI/LEFS and pain perception, suggest both more closely address cognitive or perceptual aspects of patient disability than objective measures of function. Given the lower correlation with self-report pain at discharge, we would also conclude that those who understand the program philosophy (i.e., that functional gains must occur prior to potential decreases in pain), show increases in self-reported and objective functioning, even though they still report pain.

While our data did indicate a modest decrease in pain, this is not surprising. Clinically, we often notice changes in pain occurring after extended periods of increased functioning. While we anticipated changes in pain would be associated with improvements in functioning, the lack of this finding is not surprising, especially after only 3 weeks of rehabilitation.

4.4. Limitations

This study did have limitations that should be addressed, many of which point to areas for future research. First, neither self-report nor objective measures had control groups consisting of

adolescents without pain or adolescents with chronic pain not undergoing pain rehabilitation; future research could examine LEFS and UEFI as outcome measures using a group comparison model. Second, formal long-term changes in functioning were not assessed; while short term changes were captured, one cannot assume gains will be maintained at home. It will be important for future studies to assess functioning at a distant time point after rehabilitation to evaluate carryover effects of rehabilitation. Third, the objective measures originally used and collected for this study may not be the most suitable to accurately reflect change in functional strength and endurance. Further research and application of alternative functional strength and endurance exercises may be more helpful.

5. Conclusion

Impaired physical functioning is a significant issue for adolescents with chronic pain as it impacts his/her abilities and perception of capabilities to participate in age-appropriate activities. The measures used for this study (LEFS, UEFI, objective exercises) provide a realistic and meaningful way to track progress in chronic pain rehabilitation. In addition the use of objective measures of physical functioning support self-report assessments and further validates patient improvement. Although both measures may be helpful they both identify different components of the rehabilitation process in regards to return to age appropriate functioning and were found to be separate constructs. In this study gains are not directly linked to the noted reduction in pain over the 3 weeks of rehabilitation however was also not surprising due to the short time span of three weeks. Regression statistics suggest that functional improvements are independent of self-report pain reports and should be evaluated as a separate outcome in pain rehabilitation. It is uncertain what factors predict short term reductions in pain, but cognitive or emotional changes in response to rehabilitation are likely involved.

6. Implications

The use of self-report measures along with objective measures can help therapists gain understanding in regards to a patient's insight and how that may impact their overall outcome compared to the use of a single outcome measure. It was helpful that the measures were realistic to use and review in a clinical setting. Using a verbal pain scale (0–10), self-rated functional scales, and functional strengthening exercises to track progress can also be implemented across various settings. The ability to easily view these measures at any point in the rehabilitation process can be useful to facilitate discussion about challenges the adolescent can identify and how therapies can facilitate improvement and functional gains. Given that therapy goals are patient specific, this method allows one to aggregate data across patients to evaluate the program, not just the patient. Further research should include evaluation of alternate objective measures to better capture functional strength and endurance. In addition, research using short and long term follow up data to assess maintenance of functional gains could be valuable to improve understanding of adolescents' functional gains in intensive rehabilitation programs.

Author contributions

HK, RH, and EB all contributed to conceptualization and design, literature review, and some components of manuscript. HK collected data for this study using REDCap database [20]. EB ran data for statistics and data analysis. HK and EB created figures and tables.

HK, EB, and RH completed further editing and critical revisions to prepare and submit manuscript.

Ethical issues

Data for this study was extracted retrospectively from an IRB-approved clinical database. All data collection procedures are overseen by our IRB. Information about data collection was provided to participants with an option to opt out of the clinical database, however written informed consent was not required. There were no adverse events reported as part of this study.

Source of support

There are no financial disclosures for this paper.

Conflict of interest statement

There are no conflicts of interest with this paper.

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