ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2014;95:2078-85

ORIGINAL ARTICLE

# Tracking Functional Status Across the Spinal Cord Injury Lifespan: Linking Pediatric and Adult Patient-Reported Outcome Scores

Feng Tian, PhD,[a] Pengsheng Ni, MD, MPH,[a] M.J. Mulcahey, OTR\L, PhD,[b] Ronald K. Hambleton, PhD,[c] David Tulsky, PhD,[d] Stephen M. Haley, PhD,[a,†] Alan M. Jette, PT, PhD[a]

*From the [a]Boston University School of Public Health, Health & Disability Research Institute, Boston, MA; [b]Jefferson School of Health Professions, Thomas Jefferson University, Philadelphia, PA; [c]University of Massachusetts, Amherst, MA; and [d]University of Michigan, Ann Arbor, MI.*
*†Deceased.*

**Abstract**

**Objective:** To use item response theory (IRT) methods to link scores from 2 recently developed contemporary functional outcome measures, the adult Spinal Cord Injury—Functional Index (SCI-FI) and the Pedi SCI (both the parent version and the child version).

**Design:** Secondary data analysis of the physical functioning items of the adult SCI-FI and the Pedi SCI instruments. We used a nonequivalent group design with items common to both instruments and the Stocking-Lord method for the linking. Linking was conducted so that the adult SCI-FI and Pedi SCI scaled scores could be compared.

**Setting:** Community.

**Participants:** This study included a total sample of 1558 participants. Pedi SCI items were administered to a sample of children (n=381) with SCI aged 8 to 21 years, and of parents/caregivers (n=322) of children with SCI aged 4 to 21 years. Adult SCI-FI items were administered to a sample of adults (n=855) with SCI aged 18 to 92 years.

**Interventions:** Not applicable.

**Main Outcome Measures:** Five scales common to both instruments were included in the analysis: Wheelchair, Daily Routine/Self-care, Daily Routine/Fine Motor, Ambulation, and General Mobility functioning.

**Results:** Confirmatory factor analysis and exploratory factor analysis results indicated that the 5 scales are unidimensional. A graded response model was used to calibrate the items. Misfitting items were identified and removed from the item banks. Items that function differently between the adult and child samples (ie, exhibit differential item functioning) were identified and removed from the common items used for linking. Domain scores from the Pedi SCI instruments were transformed onto the adult SCI-FI metric.

**Conclusions:** This IRT linking allowed estimation of adult SCI-FI scale scores based on Pedi SCI scale scores and vice versa; therefore, it provides clinicians with a means of tracking long-term functional data for children with an SCI across their entire lifespan.

Archives of Physical Medicine and Rehabilitation 2014;95:2078-85



Despite advances in outcome measurement, comparison of outcomes between pediatric and adult patient-reported outcomes (PROs) is not yet possible. This limitation is a major barrier to evaluating and comparing treatment effectiveness across the developmental continuum, and in monitoring long-term outcomes for children with spinal cord injury (SCI).

Classical test theory approaches have developed cross-walk tables for rehabilitation instruments, including comparing the FIM and minimal data set (MDS) items and scores[1] and the FIM and MDS—postacute care scores.[1,2] These approaches have yielded only marginally useful results, with important discrepancies found

Supported by the U.S. Department of Education, National Institute of Disability and Rehabilitation Research (grant nos. H133N060022, H133N060024, H133N060014, H133N060005, H133N060027, H133N060032) and by Shriners Hospitals for Children (grant no. 9146).

Disclosures: none.

0003-9993/14/$36 - see front matter © 2014 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2014.05.023

in certain item-to-item matches and with a low degree of agreement in assigning patients into different case-mix groups in the prospective payment systems using FIM scores and translated MDS−postacute care scores. Objections to using classical test theory methods to link measures include the potential for error that occurs when expert panels develop item-to-item matches and problems with test dependency.[3]

One important advantage of contemporary outcome measurement methods, such as item response theory (IRT), is the capability to compare scores from different PROs measuring the same construct by putting different tests on the same metric, a procedure usually referred to as linking.[4,5] IRT methods develop correspondence tables and figures to provide interchangeable scores across different instruments measuring the same construct. To overcome test dependency, both instruments are placed onto a common metric, and linking is accomplished by transforming the scores from one test to correspond to the metric of the second.

Recently, 2 separate item banks were developed for assessing physical functioning for people with SCI, one for children,[6] named the Pedi SCI (including child- and parent-reported versions), and one for adults,[7] named the Spinal Cord Injury−Functional Index (SCI-FI).[8,9]

The aim of this study was to link the Pedi SCI and SCI-FI as a way to assess functional outcomes of children with SCI as they age into adulthood. The linking between the pediatric and adult outcomes instruments provides, for the first time ever, the capability to track the function of a child with SCI across the lifespan. With this ability, long-term data on the function of children with an SCI can be obtained.

# Methods

## Samples

The Pedi SCI sample consisted of a convenience sample of 381 children with traumatic and nontraumatic SCI aged 8 to 21 years and 322 parents/caregivers of children with SCI aged 4 to 21 years. Children were enrolled if they had been discharged from initial SCI rehabilitation and returned to their preinjury environment for at least 3 months, and provided written informed assent. Children were excluded if English was not their primary language, if they were dependent on mechanical ventilation, and were unable to communicate using verbal expression. Data were collected within the Shriners Hospitals for Children System (Philadelphia, Chicago, and Northern California hospitals). Time since injury and diagnosis (paraplegia or tetraplegia), and completeness (American Spinal Injury Association Impairment Scale complete [A], sensory incomplete [B], and motor incomplete [C\D]) were recorded based on the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI).[10] Children with spina bifida, spinal muscular atrophy, or other congenital forms of spine dysfunction were excluded.

The sample for the SCI-FI included 855 participants with traumatic SCI aged 18 to 92 years who were recruited from 6 Spinal Cord Injury Model System centers: New England Regional, University of Michigan, Northern New Jersey, Rocky Mountain Regional, Mount Sinai, and Midwest Regional. Inclusion criteria included being 18 years or older and having the ability to speak and understand English. The sample was stratified by injury level (paraplegia vs tetraplegia) and completeness (complete vs incomplete), as well as time since injury (<1y, 1−3y, >3y).

For the SCI-FI sample, the diagnoses and completeness data were collected by self-report and verified by medical record review. For the Pedi SCI sample, the diagnoses and completeness data were obtained from medical records if there was a recent (≤1y) ISNCSCI examination performed. For subjects without an ISNCSCI or without a recent ISNCSCI (performed within the previous 12mo), the ISNCSCI motor, sensory, and rectal examinations were performed to classify the level and completeness of injury. The institutional review board at each site reviewed and approved this study.

## SCI item banks

The Pedi SCI item pool consists of 407 functional items separated into 178 core and 229 supplementary items. Core items were relevant to and completed by all participants. Supplementary items were completed only by participants to whom they applied and included items specific to age groups, techniques used for bowel and bladder management, mode of mobility (power/manual wheelchair, walking), and use of adaptive equipment. While there are 6 major content domains in the Pedi SCI, the 4 domains in this study include (1) General Mobility, (2) Wheeled Mobility, (3) Daily Routine, and (4) Ambulation. General mobility includes items that pertain to functioning such as body transfers, bed mobility, and pressure reliefs, whereas wheeled mobility and ambulation pertain to functioning in the wheelchair (power or manual) and upright (standing on 2 feet), respectively.

The SCI-FI item pool consists of 145 core and 130 supplementary items. Core items were completed by all participants. Supplementary items were completed only by participants to whom they applied and included items specific for sexual function, bowel and bladder management, mode of mobility (power/manual wheelchair, walking), and use of adaptive equipment. There are 5 major activity domains in the SCI-FI, which are (1) Basic Mobility, (2) Wheelchair, (3) Self-care, (4) Fine Motor, and (5) Ambulation. The items in the Pedi SCI Daily Routine domain reflect, among other areas, self-care and fine motor and are similar to the items in the SCI-FI Self-care and Fine Motor domains. Therefore, 2 domains in the SCI-FI—Self-care and Fine Motor—correspond to and were linked to the Daily Routine domain in the Pedi SCI.

To develop consistency in terminology, we refer to the domains as General Mobility, Wheeled Mobility, Daily Routine/Self-care, Daily Routine/Fine Motor, and Ambulation. For both the Pedi SCI and the SCI-FI, separate unidimensional item banks were built for each content domain.

Both the SCI-FI and Pedi SCI items used a 5-point difficulty rating scale (0, unable to do; 1, with much difficulty; 2, with some

***List of abbreviations:***

| | |
|---|---|
| **CFA** | **confirmatory factor analysis** |
| **CFI** | **comparative fit index** |
| **DIF** | **differential item functioning** |
| **EFA** | **exploratory factor analysis** |
| **IRT** | **item response theory** |
| **ISNCSCI** | **International Standards for Neurological Classification of Spinal Cord Injury** |
| **MDS** | **minimal data set** |
| **PRO** | **patient-reported outcome** |
| **SCI** | **spinal cord injury** |
| **SCI-FI** | **Spinal Cord Injury−Functional Index** |
| **TLI** | **Tucker-Lewis index** |

**Table 1** CFA and EFA results

| Domain | CFA | | | EFA | | |
|---|---|---|---|---|---|---|
| | CFI | TLI | RMSEA | % of Variance Accounted for by 1st Factor | Ratio of Eigenvalue Between 1st and 2nd Factor | Factor Loadings in 1-Factor Solution |
| Child-reported data | | | | | | |
| Wheeled Mobility | .935 | .980 | .147 | 67.2 | 8.2 | .53—.99 |
| Daily Routine | .988 | .998 | .089 | 86.2 | 28.0 | .73—.99 |
| General Mobility | .986 | .985 | .091 | 74.4 | 10.1 | .79—.97 |
| Ambulation | .962 | .958 | .120 | 67.3 | 5.8 | .68—.89 |
| Parent-reported data | | | | | | |
| Wheeled Mobility | .952 | .990 | .159 | 72.8 | 10.6 | .62—.99 |
| Daily Routine | .987 | .997 | .119 | 86.1 | 28.6 | .72—.99 |
| General Mobility | .992 | .991 | .108 | 81.3 | 18.6 | .68—.96 |
| Ambulation | .980 | .978 | .127 | 69.2 | 5.5 | .52—.95 |

Abbreviation: RMSEA, root mean square error of approximation.

difficulty; 3, with little difficulty; 4, without difficulty); higher scores mean more functional ability.

## Linking design

We used the nonequivalent groups common-item design[11] because 50 core items from the Pedi SCI were embedded in the SCI-FI item pools. Having a set of core items administered in both samples allowed for linking the 2 item banks, and this design preserves the original item calibration of the 2 item banks.

Linking refers to the general procedure of transforming scores from different instruments to make them comparable.[11] In this study, 2 different instruments are linked to be on the same scale, and since the adult and child populations are likely to be at different places on the scale, this linking procedure is referred to as "vertical scaling."[11]

## Data analysis

### Unidimensionality

Most IRT models assume that item responses constitute a unidimensional data set.[12,13] One commonly used method to check this assumption is the factor analysis.[12,13] Since the unidimensionality of the SCI-FI domains has been documented previously,[8] dimensionality analyses were not conducted for the SCI-FI banks. In the pediatric sample, confirmatory factor analysis (CFA) was conducted with the mean- and variance-adjusted weighted least square estimator. CFA model fit was assessed using the comparative fit index (CFI) and the Tucker-Lewis index (TLI). CFI and TLI values range from 0 to 1; values >.90 suggest acceptable fit.[14] The root mean square error of approximation[15] was also calculated; root mean square error of approximation values <.06 indicate close model fit.[12] If the CFA showed poor fit, then an exploratory factor analysis (EFA) was used to determine the underlying structural patterns. Because the items were polytomous, we used an unweighted least squares estimator with Geomin rotation based on a polychoric correlation matrix. The ratio of first eigenvalue to the second (a value >4 is supportive of the unidimensionality assumption) and the percentage of the total variance explained by the first factor (at least 20% is desirable) were used to assess unidimensionality.[12] Both EFA and CFA were conducted using the MPlus software version 6.0.[a]

### Item calibration and item fit

Item parameter estimates for the SCI-FI items were obtained in previous work.[9] To obtain item parameters for Pedi SCI, we used the graded response model[16] for each domain separately as was done in the SCI-FI calibration. We calibrated items with the marginal maximum likelihood estimation using PARSCALE.[b] Item fit was tested using the likelihood ratio test[17] and the Stone G statistics test[18]; $P<.05$ indicated item misfit.

### Differential item functioning of common items

We examined the quality of the common 50 items. They were initially analyzed for differential item functioning (DIF). DIF occurs when factors other than the ability of the person influence responses.[13] We evaluated 2 kinds of DIF using ordinal logistic regression.[19] One is uniform DIF,[12] in which item response probabilities differ consistently across all ability levels between groups (adult vs pediatric). The second is nonuniform DIF,[12] in

**Table 2** Distribution of items by domain in SCI-FI scales and Pedi SCI scales and of items common to both scales

| SCI-FI Content Domain | No. of Items | Pedi SCI Content Domain | Final No. of Items in Item Bank | | Final No. of Common Items |
|---|---|---|---|---|---|
| | | | Parent-Reported Data | Child-Reported Data | |
| Wheeled Mobility | 56 | Wheeled Mobility | 64 | 62 | 25 |
| Daily Routine/Self-care | 90 | Daily Routine | 185 | 192 | 5 |
| Daily Routine/Fine Motor | 36 | Daily Routine | | | 4 |
| Ambulation | 39 | Ambulation | 25 | 25 | 5 |
| General Mobility | 54 | General Mobility | 18 | 19 | 6 |
| Total | 275 | | 292 | 298 | 45 |

**Table 3** Mean difficulty parameters of common items and item bank, and correlation of scores based on common items and item bank

| Domain | Mean Difficulty Parameters | | Correlation Coefficient of Scores Based on Common Items and Item Bank |
|---|---|---|---|
| | Item Bank | Common Items | |
| Pedi SCI | | | |
| Parent-reported data | | | |
| Wheeled Mobility | −2.17 | −2.11 | .94 |
| Daily Routine/ Self-care | −1.05 | −1.23 | .91 |
| Daily Routine/ Fine Motor | −1.05 | −1.43 | .81 |
| Ambulation | −1.62 | −1.89 | .91 |
| General Mobility | −0.79 | −0.91 | .84 |
| Child-reported data | | | |
| Wheeled Mobility | −1.56 | −1.52 | .97 |
| Daily Routine/ Self-care | −0.82 | −0.74 | .92 |
| Daily Routine/ Fine Motor | −0.82 | −1.01 | .84 |
| Ambulation | −0.72 | −0.86 | .97 |
| General Mobility | −0.39 | −0.49 | .90 |
| SCI-FI | | | |
| Wheeled Mobility | −0.51 | −0.64 | .98 |
| Daily Routine/ Self-care | −0.46 | −0.60 | .95 |
| Daily Routine/ Fine Motor | −0.48 | −0.66 | .90 |
| Ambulation | 1.57 | 1.29 | .95 |
| General Mobility | 0.04 | 0.18 | .93 |

which item response probabilities vary between groups along ability levels. The dependent variable was responses to an item. Three independent variables included the ability level measured with the total raw score on the common items, the group membership, and an interaction term between the ability level and the group membership. The analytic strategy was to successively add ability level, group membership, and interaction term into the model, and the procedure was repeated for each item. A significant group membership effect indicated the presence of uniform DIF, and a significant interaction term indicated nonuniform DIF. Model comparisons were based on the likelihood ratio test. The effect size of the DIF was classified based on the $R^2$ change between models.[20] An $R^2$ change of $<.035$ was judged to indicate an unimportant DIF; an $R^2$ change of .035 to .07, moderate DIF; and an $R^2$ change of $>.07$, substantial DIF.[20] Items showing moderate or substantial DIF would be removed from the linking process. Although the DIF-free items served as the common link between items of the 2 item banks, the relationship based on the common items was applied to the whole item bank. As such, we examined the mean difficulty parameter of the common items and the item bank and the correlation between scores based on the common items and those based on the item bank to see how the common items represented the item bank. We also examined the correlations of the difficulty parameters of the common items from the SCI-FI and Pedi SCI.

**Table 4** Correlation coefficients of difficulty parameters of common items between SCI-FI scales and Pedi SCI scales

| Domain | Correlation Coefficients |
|---|---|
| Parent-reported data | |
| Wheeled Mobility | .95 |
| Daily Routine/Self-care | .97 |
| Daily Routine/Fine Motor | .98 |
| Ambulation | .90 |
| General Mobility | .86 |
| Child-reported data | |
| Wheeled Mobility | .94 |
| Daily Routine/Self-care | .96 |
| Daily Routine/Fine Motor | .90 |
| Ambulation | .90 |
| General Mobility | .73 |

**Table 5** Summary of linking coefficients by domains

| Domain | Linking Coefficients | |
|---|---|---|
| | A | B |
| Child-reported data | | |
| Wheeled Mobility | 0.73 | 0.91 |
| Daily Routine/Self-care | 0.75 | 0.36 |
| Daily Routine/Fine Motor | 0.67 | 0.30 |
| Ambulation | 0.54 | 1.76 |
| General Mobility | 0.72 | 0.84 |
| Parent-reported data | | |
| Wheeled Mobility | 0.87 | 0.55 |
| Daily Routine/Self-care | 0.95 | 0.23 |
| Daily Routine/Fine Motor | 0.89 | 0.31 |
| Ambulation | 1.13 | 3.43 |
| General Mobility | 0.73 | 0.55 |

### Linking

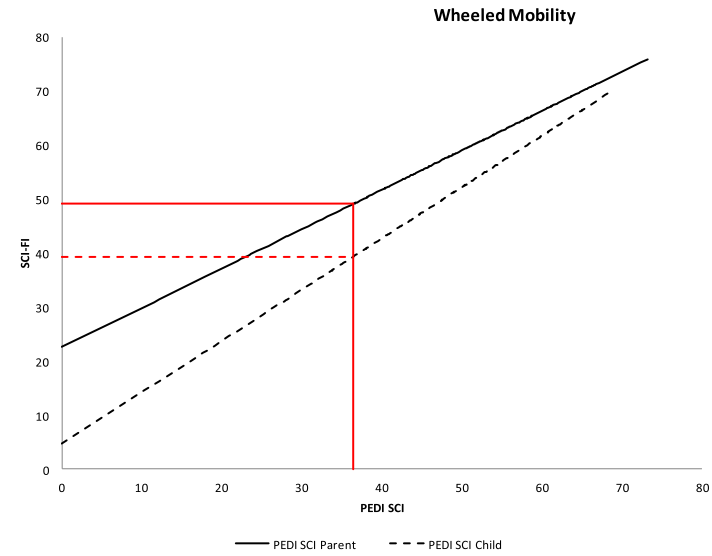
We used the Stocking-Lord method, which takes parameters of the common items and applies a transformation to them such that the test characteristic curve of one measure (Pedi SCI) is as similar as possible to that of the other measure (SCI-FI).[11] To accomplish this, linking coefficients (denoted as A, B) were estimated, which minimize the weighted sum of squared distances between the 2 test characteristic curves based on the common items. The linking was conducted by using the IRTEQ software (version 1.1[c]). With A and B, the Pedi SCI scale was transformed linearly onto the SCI-FI scale following the equation $\theta_{Adult} = \theta_{Pedi} \times A + B$.

## Results

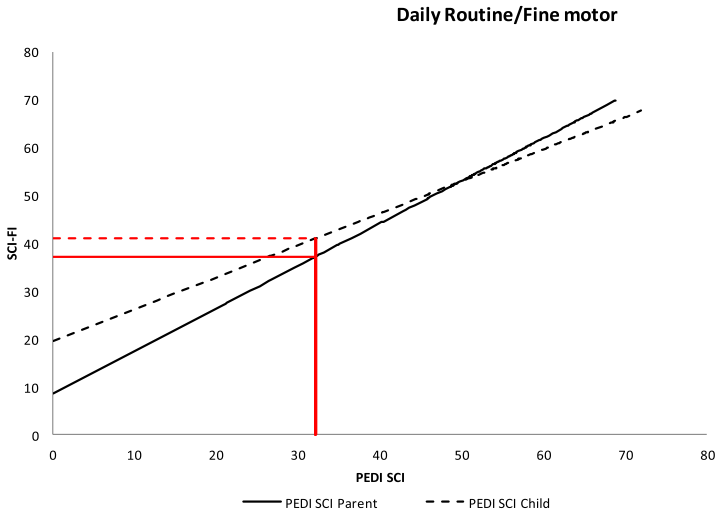
### Sample characteristics

#### Pedi SCI sample

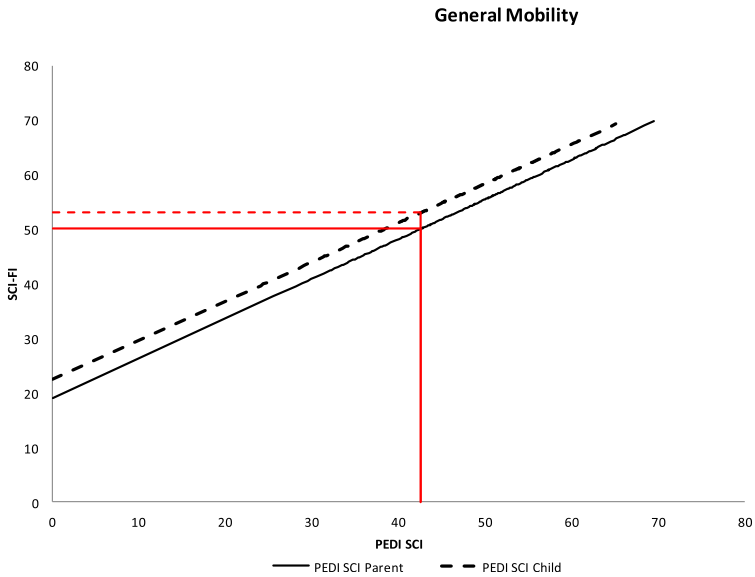
For the child-reported version of Pedi SCI, the mean age ± SD of the participants was 15.5±3.5 years. Most subjects were boys (55%) and white (82%); 57.6% had paraplegia and 54.2% had completed injuries. For the parent-reported version, the mean age




Note: the linear transformation formula of the scaled score are as follows $\theta_{Adult} = \theta_{Pedichild} \times 0.73 + 22.6$ and $\theta_{Adult} = \theta_{Pedicparent} \times 0.87 + 7.7$. A scaled score of 36.4 on both the parent- and child-reported Pedi SCI Wheeled Mobility scale is comparable to a scaled score of 49.2 and 39.4 respectively on the adult SCI-FI Wheeled Mobility scale.




Note: the linear transformation formula of the scaled score are as follows $\theta_{Adult} = \theta_{Pedichild} \times 0.67 + 15.6$ and $\theta_{Adult} = \theta_{Pedicparent} \times 0.89 + 12.4$. A scaled score of 32.1 on both the parent- and child-reported Pedi SCI Daily Routine scale is comparable to a scaled score of 37.1 and 41 respectively on the adult SCI-FI Daily Routine/ Fine Motor scale




Note: the linear transformation formula of the scaled score are as follows $\theta_{Adult} = \theta_{Pedichild} \times 0.73 + 19$ and $\theta_{Adult} = \theta_{Pedicparent} \times 0.72 + 22.4$. A scaled score of 42.6 on both the parent- and child-reported Pedi SCI General Mobility scale is comparable to a scaled score of 50.1 and 53.1 respectively on the adult SCI-FI General Mobility scale

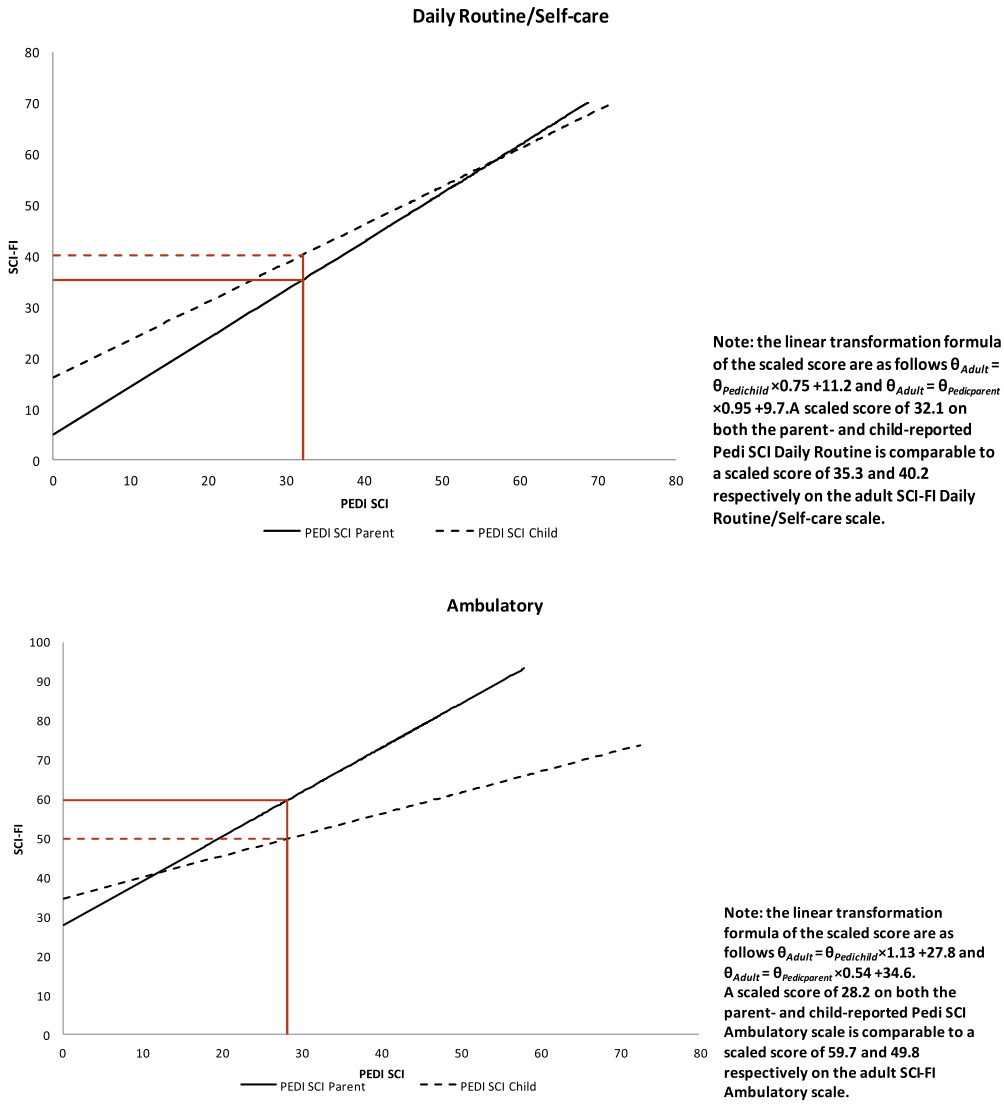



**Fig 1** Scaled score conversions for the Wheeled Mobility, Daily Routine/Self-care, Daily Routine/Fine Motor, Ambulation, and General Mobility scales.

± SD of the participating children was 13.6±4.5 years. Most subjects were also boys (55%) and white (82%); 56% had paraplegia and 52% had complete injuries. Details of the sample have been reported previously.[21]

### Adult SCI-FI sample

The mean age ± SD of the adult participants was 43.1±15.1 years. Most participants were men (77%) and white (70%); 46% had paraplegia and 46% complete injuries. Details of the sample have been reported previously.[9]

## Unidimensionality

Table 1 presents the results of the EFA and CFA of the Pedi SCI. All the CFI and TLI values are above the .90 cutoff point. The first factor explained 67% to 86% of the total variance, with a ratio of 6 to 28 between the first and the second eigenvalues. The combined evidence from EFA and CFA showed that all the domains in both child-reported and parent-reported data are unidimensional.

### Item calibration and item fit

For the child-reported version, 2 Daily Routine items and 2 Wheeled Mobility items showed misfit in both the likelihood ratio test and Stone G statistic; for the parent-reported version, 9 Daily Routine items and 2 General Mobility items showed misfit. These items were removed from the item bank. Items and item parameters of the 4 item banks are available in supplemental appendices S1 and S2 (available online only at http://www.archives-pmr.org/).

### DIF of common items

Four Wheeled Mobility items and 1 General Mobility item were classified as showing moderate or substantial DIF. These items were not used in the linking. The final data set included 45 common items. The distribution of items for each domain is shown in table 2.

As shown in table 3, the mean item difficulty parameters are generally close between the item bank and the common items for both the Pedi SCI and SCI-FI scales. Correlation between the

scores based on the common items and those based on the item bank ranged from .81 to .97. Correlation of the difficulty parameters of the common items between the SCI-FI scales and Pedi SCI scales ranged from .73 to .98 (table 4).

### Linking

The results for linking the Pedi SCI with the SCI-FI are summarized in table 5. The original person scores generated from IRT software are in log-odds (logit) units. To ease interpretation, logit scores were transformed to T scores by having a mean ± SD score of 50±10 for all the common domains between the SCI-FI and Pedi SCI. Figure 1 shows the linear transformation of the scores.

## Discussion

In this study, we linked scores from 2 recently developed contemporary functional outcome measures that allows for monitoring the function of children across their lifespan. We believe this is the first work to describe a common scale that makes it possible to evaluate and compare outcomes across the lifespan. Although linking methods have been used for years in education to link scores from achievement tests across grade levels, they have been less frequently applied in health status assessment and have not yet been described to link pediatric and adult scales. With methodological advances such as IRT, placing items from different PRO instruments on a common metric and developing a linkage between their scores can be achieved,[4,5] which allows one to identify scores on different measures that have comparable meaning.

This study has significant relevance for pediatric SCI rehabilitation and research. An important component of the standard of care of SCI rehabilitation is the use of precise and meaningful outcome instruments that have sound psychometric properties and that can inform decisions about immediate and long-term health care decisions. A common instrument to pediatric and adult practice will bridge standards associated with the manner in which these outcomes instruments are administered and the type of information that is used to inform decisions, now and as the child ages. In addition to bridging clinical practice, linking the outcomes instrument may potentially expand the research opportunity for children. Compared with adults, children with SCI are chronically underrepresented in SCI clinical trials and effectiveness studies, in part because of the lack of pediatric psychometric studies on the instrument used. We describe an instrument that may help to address the underrepresentation of children in studies because of the unavailability of an instrument that can be used across the age span. Most importantly, there is now an ability to keep track of and compare outcomes of children with SCI as they age into adulthood.

An important element of this work involves the linking of both a parent-reported scale and a child-reported scale to the SCI-FI scale. While they may differ, there is a general understanding that parent- and child-reported outcomes contribute equally to the overall assessment, and both perspectives provide important information.[22-24]

An interesting question pertains to the rationale for developing separate scales for children and adults. Conceptualization of the Pedi SCI scales originally focused on play and school and a response scale appropriate for child report. Through iterative focus groups and content expert consensus building,[6,25] scales were expanded to include self-care and mobility items as well as a response choice for parent report; it was at this point in scale development where appropriate pediatric self-care and mobility items were shared with adult scale developers. While there are subtle differences between conceptualization of the pediatric and adult response scales and a predominance of school and play items in the pediatric scale, the scales are quite similar. The work described in this article may catalyze earlier and stronger collaboration between adult and pediatric researchers that could potentially advance the field from linking pediatric and adult measures to developing common measures across the age continuum.

### Study limitations

There are several limitations in these analyses. First, when only a small number of common items are available in linking, there is a risk of not being able to obtain precise linking coefficients. Second, although precise estimation of IRT item parameters requires adequate sample size, there are no definitive sample size requirements for IRT application. A general guideline is that more complex models and longer instruments will require larger sample sizes. Some studies[26-28] suggest that item parameters could be well estimated for samples between 200 and 300, but a sample size of 500, recommended by Reise and Yu,[29] is considered adequate for the graded response model. Although the sample size for the calibration of the pediatric data is >300, it is smaller than the recommended 500 and may adversely affect the precision of the item parameter estimates. Although both samples were classified according to the ISNCSCI, and the breakdown of complete and incomplete injuries as defined by the American Spinal Injury Association Impairment Scale was comparable, the pediatric sample included acquired traumatic and nontraumatic injuries. The accuracy of the results from this study remains to be validated.

## Conclusions

This study provides clinicians with a means of tracking long-term functional data for children with an SCI across their entire lifespan, something that has never been possible before. Comparisons between outcomes in children and adults are now feasible and will potentially bridge the gap between standards of care and benchmarks. The lack of a common functional outcome instrument for children and adults is no longer a reason to exclude youths from SCI clinical trials and effectiveness studies, thereby increasing the opportunity to build evidence in support of treatment and standards of care for SCI rehabilitation regardless of age.

## Suppliers

a. Muthen & Muthen, 3463 Stoner Ave, Los Angeles, CA 90066.
b. Scientific Software, 7383 N Lincoln Ave, Ste 100, Lincolnwood, IL 60712.
c. University of Massachusetts Amherst, Center for Educational Assessment,152 Hills South, Amherst, MA, 01003.

## Keywords

Outcome assessment (health care); Psychometrics; Rehabilitation; Spinal cord injuries

## Corresponding author

Feng Tian, PhD, Boston University School of Public Health, Health & Disability Research Institute, 715 Albany St, T5W, Boston, MA 02118-2526. *E-mail address:* tianfeng@bu.edu.

## References


1. Williams BC, Li Y, Fries BE, Warren RL. Predicting patient scores between the Functional Independence Measure and the minimum data set: development and performance of a FIM-MDS "crosswalk." Arch Phys Med Rehabil 1997;78:48-54.
2. Buchanan JL, Andres PL, Haley SM, Paddock SM, Zaslavsky AM. An assessment tool translation study. Health Care Financ Rev 2003; 24:45-60.
3. Buchanan JL, Andres PL, Haley SM, Paddock SM, Zaslavsky AM. Evaluating the planned substitution of the minimum data set-post acute care for use in the rehabilitation hospital prospective payment system. Med Care 2004;42:155-63.
4. Hambleton RK. Applications of item response theory to improve health outcomes assessment: developing item banks, linking instruments, and computer-adaptive testing. In: Lipscomb J, Gotay CC, Snyder C, editors. Outcomes assessment in cancer. Cambridge: Cambridge University Pr; 2005. p 445-64.
5. Dorans NJ. Linking scores from multiple health outcome instruments. Qual Life Res 2007;16(Suppl 1):85-94.
6. Calhoun CL, Haley SM, Riley A, Vogel LC, McDonald CM, Mulcahey MJ. Development of items designed to evaluate activity performance and participation in children and adolescents with spinal cord injury. Int J Pediatr 2009:854-904.
7. Slavin MD, Kisala PA, Jette AM, Tulsky DS. Developing a contemporary functional outcome measure for spinal cord injury research. Spinal Cord 2010;48:262-7.
8. Tulsky DS, Jette AM, Kisala PA, et al. Spinal Cord Injury-Functional Index: item banks to measure physical functioning in individuals with spinal cord injury. Arch Phys Med Rehabil 2012;93:1722-32.
9. Jette AM, Tulsky DS, Ni P, et al. Development and initial evaluation of the Spinal Cord Injury-Functional Index. Arch Phys Med Rehabil 2012;93:1733-50.
10. American Spinal Injury Association. International Standards for Neurological Classification of Spinal Cord Injury, revised 2011. Atlanta: American Spinal Injury Association; 2011.
11. Kolen MJ, Brennan RL. Test equating, scaling, and linking: methods and practices. 2nd ed. New York: Springer-Verlag; 2004:372.
12. Reeve BB, Hays RD, Bjorner JB, et al. Psychometric evaluation and calibration of health-related quality of life item banks: plans for the Patient-Reported Outcomes Measurement Information System (PROMIS). Med Care 2007;45(5 Suppl 1):S22-31.
13. Thissen D, Reeve BB, Bjorner JB, Chang CH. Methodological issues for building item banks and computerized adaptive scales. Qual Life Res 2007;16(Suppl 1):109-19.
14. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Modeling 1999;6:1-55.
15. Browne MW, Cudeck R. Alternative ways of assessing model fit. In: Bollen KA, Long JS, editors. Testing structural equation models. Newbury Park: Sage; 1993. p 136-62.
16. Samejima F. Graded response model. In: van der Linden WJ, Hambleton RK, editors. Handbook of modern item response theory. New York: Springer; 1997. p 85-100.
17. Muraki E, Bock RD. PARSCALE: IRT item analysis and test scoring for rating—scale data. Chicago: Scientific Software International; 1997.
18. Stone CA. Empirical power and type I error rates for an IRT fit statistic that considers the precision of ability estimates. Educ Psychol Meas 2003;63:566-83.
19. Zumbo BD. A handbook on the theory and methods of differential item functioning (DIF): logistic regression modeling as a unitary framework for binary and Likert-type (ordinal) item scores. Ottawa: Directorate of Human Resources Research and Evaluation, Department of National Defense; 1999.
20. Jodoin MG, Gierl MJ. Evaluating type I error and power rates using an effect size measure with the logistic regression procedure for DIF detection. Appl Meas Educ 2001;4:329-49.
21. Mulcahey MJ, Calhoun CL, Tian F, Ni P, Vogel LC, Haley SM. Evaluation of newly developed item banks for child-reported outcomes of participation following spinal cord injury. Spinal Cord 2012; 50:915-9.
22. Vetter TR, Bridgewater CL, McGwin G Jr. An observational study of patient versus parental perceptions of health-related quality of life in children and adolescents with a chronic pain condition: who should the clinician believe? Health Qual Life Outcomes 2012;10:85.
23. Varni JW, Limbers CA, Burwinkle TM. Parent proxy-report of their children's health-related quality of life: an analysis of 13,878 parents' reliability and validity across age subgroups using the PedsQL 4.0 Generic Core Scales. Health Qual Life Outcomes 2007;5:2.
24. Gabbe BJ, Simpson PM, Sutherland AM, et al. Agreement between parent and child report of health-related quality of life: impact of time postinjury. J Trauma 2010;69:1578-82.
25. Mulcahey MJ, Calhoun C, Riley A, Haley S. Children's report of activity and participation after sustaining a spinal cord injury: a cognitive interview study. Dev Neurorehabil 2009;12:191-200.
26. Drasgow F. An evaluation of marginal maximum likelihood estimation for the two-parameter logistic model. Appl Psychol Meas 1998;13:77-90.
27. Harwell MR, Janosky JE. An empirical study of the effects of small datasets and varying prior variances on item parameter estimation in BILOG. Appl Psychol Meas 1991;15:279-91.
28. Chuah SC, Drasgow F, Luecht R. How big is big enough? Sample size requirements for CAST item parameter estimation. Appl Meas Educ 2006;19:241-55.
29. Reise SP, Yu J. Parameter recovery in the graded response model using MULTILOG. J Educ Meas 1990;27:133-44.

**Supplemental Table S1** Item parameters for each Pedi SCI content domain (parent version)

Ambulation Domain

| Item | Discrimination* | Threshold 1† | Threshold 2† | Threshold 3† | Threshold 4† |
|---|---|---|---|---|---|
| My child can walk from room to room in our home | 3.96 | −2.56 | −2.26 | −1.92 | −1.51 |
| My child can walk out of an elevator | 6.35 | −2.3 | −2.18 | −1.82 | −1.45 |
| My child can take a step with each foot | 3.87 | −2.65 | −2.39 | −2 | −1.57 |
| My child can walk in therapy | 4.87 | −2.99 | −2.6 | −1.88 | −1.43 |
| My child can walk while carrying a shopping bag in one hand | 4.52 | −1.79 | −1.63 | −1.32 | −0.91 |
| My child can walk on grass outside | 9.12 | −2.28 | −1.94 | −1.61 | −1.28 |
| My child can walk in a busy hallway with a lot of people | 4.99 | −2.23 | −1.91 | −1.45 | −0.88 |
| My child can walk in between a row of chairs, like at a movie theater | 5.05 | −2.13 | −1.95 | −1.54 | −1.07 |
| My child can walk on mulch or gravel outside, like at a playground | 5.57 | −2.12 | −1.8 | −1.55 | −1.1 |
| My child can step down a curb | 10.42 | −2.07 | −1.88 | −1.54 | −1.12 |
| My child can step up a curb | 7.61 | −2.1 | −1.95 | −1.57 | −1.2 |
| My child can walk up a flight of stairs using the rail | 6.74 | −1.84 | −1.68 | −1.43 | −1.06 |
| My child can walk down a flight of stairs using the rail | 8.21 | −1.71 | −1.61 | −1.4 | −1.02 |
| My child can walk down steps to get off a bus | 6.36 | −1.81 | −1.69 | −1.3 | −0.87 |
| My child can walk up steps to enter a bus | 5.98 | −1.83 | −1.67 | −1.27 | −0.87 |
| My child can run | 3.09 | −1.78 | −1.15 | −0.73 | −0.29 |
| My child can walk with a backpack on his or her back | 5.31 | −1.93 | −1.71 | −1.49 | −1.1 |
| My child can walk up a ramp or steep hill | 6.19 | −2.19 | −1.93 | −1.5 | −1.02 |
| My child can walk down a ramp or steep hill | 7.41 | −2.2 | −1.93 | −1.47 | −1.05 |
| My child can walk on a dirt path or hiking trail | 5.69 | −2.15 | −1.88 | −1.54 | −1.14 |
| My child can walk on a slippery surface, like a wet floor | 5.02 | −1.56 | −1.26 | −0.46 | NA |
| My child can walk while carrying a tray of food | 5.01 | −1.69 | −1.51 | −1.16 | −0.59 |
| My child can walk and text on the phone | 2.26 | −2.05 | −1.73 | −1.39 | −0.67 |
| My child can walk and keep his or her place in a line of moving people | 5.44 | −2.22 | −1.83 | −1.48 | −1.18 |
| My child can change direction by turning around while walking | 5.19 | −2.33 | −2.09 | −1.74 | −1.32 |

General Mobility Domain

| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
|---|---|---|---|---|---|
| My child can move him or herself in bed | 3.53 | −1.59 | −1.12 | −0.67 | −0.03 |
| When in bed, my child can roll from his or her back to side | 3.94 | −1.58 | −1.11 | −0.57 | −0.02 |
| My child can move from lying in bed to sitting at the edge | 6.31 | −1.14 | −0.89 | −0.44 | 0.09 |
| In bed, my child can get under the sheets | 3.49 | −1.30 | −1.02 | −0.54 | 0.10 |
| When sitting at the edge of the bed, my child can lean forward to reach for something | 2.75 | −0.94 | −0.53 | 0.13 | 0.61 |
| Using his or her arms for support, my child can sit on a picnic bench | 2.56 | −1.23 | −1.03 | −0.48 | 0.09 |
| My child can hold a door open while moving into a room | 2.03 | −1.64 | −1.12 | −0.18 | 0.76 |
| When in bed, my child can roll from his or her back to belly | 3.97 | −1.11 | −0.95 | −0.41 | 0.16 |
| Bumping means to go down stairs on his or her bottom. My child can bump down the stairs | 2.43 | −0.30 | −0.08 | 0.25 | 0.60 |
| Bumping means to go up the stairs on his or her bottom. My child can bump up the stairs | 2.17 | −0.15 | 0.14 | 0.43 | 0.95 |
| My child can move from sitting at the edge of the bed to lying down | 5.11 | −1.42 | −1.19 | −0.62 | −0.06 |
| Without using his or her arms for support, my child can sit on a picnic bench | 2.34 | −0.71 | −0.40 | −0.02 | 0.51 |
| My child can move on to a shower chair | 3.55 | −0.86 | −0.61 | −0.08 | 0.51 |
| My child can move off a shower chair | 3.65 | −0.84 | −0.61 | −0.10 | 0.55 |
| My child can move into a tub | 3.17 | −0.14 | 0.16 | 0.57 | 1.02 |
| My child can move out of a tub | 2.94 | −0.03 | 0.21 | 0.66 | 1.15 |
| My child can move on to a toilet | 3.37 | −0.60 | −0.32 | 0.10 | 0.50 |
| My child can move off a toilet | 3.59 | −0.54 | −0.30 | 0.10 | 0.52 |

(*continued on next page*)

**Supplemental Table S1** (*continued*)

| Daily Routine Domain | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| With two hands, my child can hold a ball | 1.97 | −2.13 | −1.67 | −1.25 | −0.75 |
| Using only one hand to hold the brush, my child can paint with a paintbrush | 3.59 | −1.48 | −1.21 | −1.01 | −0.66 |
| Using only one hand, my child can take coins out of a wallet or purse | 5.01 | −1.11 | −0.79 | −0.55 | −0.21 |
| Using one hand, my child can throw a ball | 3.57 | −1.39 | −0.91 | −0.60 | −0.22 |
| Using one hand, my child can catch a ball | 3.12 | −1.00 | −0.65 | −0.21 | 0.15 |
| My child can remove a marker cap with his or her mouth | 1.42 | −2.69 | −2.38 | −1.61 | −1.04 |
| With one hand, my child can hold a ball | 3.10 | −1.55 | −1.36 | −0.93 | −0.55 |
| Without hand splints and without using his or her mouth, my child can unwrap a chocolate bar | 3.42 | −1.15 | −1.01 | −0.62 | −0.28 |
| My child can wrap a gift with paper | 4.04 | −0.87 | −0.59 | −0.28 | 0.06 |
| Using only one hand, my child can pick up a playing card from the pile | 4.14 | −1.29 | −1.12 | −0.85 | −0.52 |
| Using two hands, my child can catch a ball | 3.09 | −1.56 | −1.26 | −0.67 | −0.16 |
| Using a universal cuff (u-cuff), my child can paint with a paintbrush | 1.56 | −2.72 | −1.44 | −0.94 | NA |
| Using a hand splints and not his or her mouth, my child can remove the cap from a marker | 1.90 | −1.53 | −1.00 | −0.68 | −0.31 |
| With a hand splint and not his or her mouth, my child can unwrap a chocolate bar | 2.35 | −1.58 | −1.08 | −0.83 | −0.27 |
| With a wrist-hand splint, my child can move a board game piece | 2.01 | −2.05 | −1.83 | −1.46 | −0.59 |
| With a wrist-hand splint, my child can use a remote to change TV channels | 1.44 | −2.15 | −1.88 | −1.48 | −0.44 |
| With a wrist-hand splint, my child can pick up Cheerios using his or her fingers | 1.58 | −1.64 | −0.88 | −0.28 | NA |
| With my wrist-hand splint, my child can pick up a playing card from the pile | 3.52 | −1.61 | −1.10 | −0.73 | −0.49 |
| With a wrist-hand splint, my child can put a puzzle piece into a puzzle | 2.91 | −1.62 | −0.97 | −0.56 | NA |
| With a wrist-hand splint, my child can wrap a gift with paper | 2.74 | −0.78 | −0.63 | −0.17 | 0.03 |
| With a wrist-hand splint, my child can pour cereal | 3.99 | −1.31 | −0.90 | −0.64 | 0.03 |
| Using only one hand, my child can set a table | 3.61 | −0.94 | −0.65 | −0.23 | 0.19 |
| With a wrist-hand splint, my child can use the video game controller | 1.28 | −2.19 | −1.82 | −1.17 | −0.68 |
| With his or her mouth, my child can open a cereal box | 1.89 | −1.35 | −0.95 | −0.38 | −0.03 |
| With a splint, my child can put a DVD or CD into the player | 4.00 | −1.27 | −1.00 | −0.65 | −0.34 |
| Using his or her mouth to hold the pen, my child can draw a picture of a person | 1.00 | −1.53 | −0.67 | −0.12 | 0.23 |
| With a wrist-hand splint, at school my child can write on the board | 2.33 | −1.40 | −0.91 | −0.59 | −0.23 |
| With a wrist-hand splint, my child can set a table | 3.93 | −1.31 | −0.75 | −0.37 | −0.27 |
| With his or her mouth, my child can draw a line using a ruler | 1.39 | −1.10 | −0.67 | −0.07 | 0.41 |
| After the food is given to him or her, with a splint, my child can make a sandwich | 4.82 | −1.44 | −0.60 | −0.10 | NA |
| With a hand splint, my child can take dollars out of a wallet or purse | 2.35 | −1.26 | −0.94 | −0.62 | −0.43 |
| With a hand splint, my child can take coins out of a wallet or purse | 1.48 | −0.58 | 0.02 | 0.43 | NA |
| My child can open hardcover books | 4.70 | −2.05 | −1.86 | −1.24 | −0.93 |
| Using all of his or her fingers, my child can pick up Cheerios | 4.15 | −1.22 | −0.99 | −0.75 | −0.43 |
| Using two hands, my child can throw a ball | 2.90 | −1.47 | −1.03 | −0.75 | −0.31 |
| Using only his or her mouth, my child can paint with a paintbrush | 0.50 | −3.48 | −2.64 | −1.43 | 0.02 |
| Using a wrist-hand splint, my child can paint with a paintbrush | 1.45 | −2.37 | −2.17 | −1.19 | −0.71 |
| Using both hands together to hold the brush, my child can paint with a paintbrush | 2.93 | −1.62 | −1.40 | −1.03 | −0.64 |
| Using his or her mouth, my child can unwrap a chocolate bar | 2.35 | −1.95 | −1.76 | −1.18 | −0.42 |
| Using his or her mouth, my child can move a board game piece | 1.31 | −1.96 | −1.69 | −1.36 | −0.85 |

(*continued on next page*)

**Supplemental Table S1** (*continued*)

| Daily Routine Domain (continued) | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| Using both hands together, my child can move a board game piece | 2.68 | −1.68 | −1.42 | −1.21 | −0.74 |
| Using two hands together to use a remote, my child can change TV channels | 2.87 | −1.77 | −1.58 | −1.40 | −0.92 |
| Using just a pointer finger and thumb, my child can pick up Cheerios | 4.52 | −1.36 | −1.12 | −0.95 | −0.54 |
| Using two hands together, my child can pick up a playing card from the pile | 3.12 | −1.48 | −1.14 | −0.96 | −0.50 |
| Using two hands to hold the puzzle, my child can put a puzzle piece into a puzzle | 3.42 | −1.28 | −1.03 | −0.70 | −0.31 |
| Using both hands together, my child can turn the pages of a book | 3.03 | −1.84 | −1.49 | −1.17 | −0.81 |
| Using only one hand, my child can turn the pages of a book | 4.44 | −1.88 | −1.33 | −1.13 | −0.64 |
| Using two hands together to hold the box, my child can pour cereal | 4.26 | −1.21 | −1.00 | −0.66 | −0.23 |
| With a wrist-hand splint, my child can draw a picture of a person | 3.07 | −1.33 | −0.77 | −0.18 | NA |
| With a universal cuff (u-cuff) my child can draw a picture of a person | 1.45 | −1.96 | −1.39 | −0.93 | −0.31 |
| Using both hands together to hold the pen, my child can draw a picture of a person | 3.06 | −1.42 | −0.99 | −0.55 | −0.24 |
| Using only one hand to hold the marker, at school, my child can write on the board | 3.03 | −1.23 | −1.07 | −0.81 | −0.38 |
| Using both hands together, my child can set the table | 3.95 | −0.97 | −0.62 | −0.28 | 0.04 |
| With a wrist-hand splint, my child can draw a line using a ruler | 2.91 | −1.44 | −0.96 | −0.56 | −0.22 |
| With a universal cuff (u-cuff), my child can draw a line using a ruler | 2.54 | −1.32 | −1.05 | −0.81 | −0.61 |
| Without any hand splints, my child can draw a line using a ruler | 3.91 | −1.11 | −0.86 | −0.67 | −0.58 |
| Using only one hand to grab money, my child can take dollars out of a wallet or purse | 4.27 | −1.29 | −0.98 | −0.64 | −0.22 |
| With two hands working together to grab the coins, my child can take coins out of a wallet or purse | 4.24 | −1.15 | −0.82 | −0.55 | −0.22 |
| My child can raise his or her hand in class | 2.26 | −2.44 | −2.18 | −1.66 | −1.29 |
| Using only one hand to use a remote, my child can change TV channels | 3.22 | −1.50 | −1.37 | −1.16 | −0.87 |
| My child can press the button to take a picture with a camera | 5.54 | −1.27 | −1.11 | −0.88 | −0.52 |
| Exercise means doing an activity like biking, swimming, or arm cycling for at least 20 minutes. My child can exercise. | 1.35 | −1.42 | −0.84 | −0.19 | 0.50 |
| My child can ride a bike using his or her arms | 1.50 | −0.33 | −0.22 | 0.08 | 0.48 |
| Using only one hand, my child can use the video game controller | 2.74 | −1.46 | −1.28 | −0.91 | −0.46 |
| Using his or her hands, my child can keyboard | 3.34 | −1.68 | −1.55 | −1.11 | −0.54 |
| Using only one hand, my child can put a puzzle piece into a puzzle | 5.17 | −1.46 | −1.04 | −0.86 | −0.46 |
| Using only one hand to hold the pen, my child can draw a picture of a person | 3.30 | −1.40 | −1.18 | −0.86 | −0.59 |
| Using both hands to hold the marker, at school, my child can write on the board | 2.75 | −1.33 | −1.19 | −0.86 | −0.52 |
| My child can finger-paint | 2.56 | −1.93 | −1.54 | −1.32 | NA |
| Using just his or her hands, my child can open a cereal box | 5.09 | −0.99 | −0.75 | −0.54 | −0.29 |
| With his or her mouth, my child can turn the pages of a book | 1.18 | −1.66 | −1.24 | −0.77 | −0.24 |
| Using only one hand, my child can pour cereal | 4.53 | −0.84 | −0.68 | −0.41 | −0.09 |
| My child can swing a baseball bat | 2.23 | −1.08 | −0.58 | −0.10 | 0.47 |
| My child can make popcorn in the microwave | 3.68 | −0.97 | −0.82 | −0.59 | −0.15 |
| My child can take clean clothes out of the dryer | 2.64 | −0.66 | −0.45 | −0.09 | 0.37 |
| My child can draw a line using a ruler | 5.27 | −1.18 | −0.90 | −0.69 | −0.35 |
| Using just his or her hands, my child can remove the cap from a marker | 4.68 | −1.30 | −1.05 | −0.78 | −0.48 |
| My child can dust a table | 2.83 | −1.77 | −1.62 | −1.08 | −0.58 |
| After the food is given to him or her, with a wrist—hand splint, my child can make a sandwich | 3.23 | −1.21 | −0.65 | −0.32 | 0.09 |

(*continued on next page*)

**Supplemental Table S1** (*continued*)

| Daily Routine Domain (continued) | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| Using only one hand, my child can move a board game piece | 3.92 | −1.99 | −1.72 | −1.27 | −0.77 |
| My child can cut with scissors | 4.44 | −0.97 | −0.78 | −0.49 | −0.22 |
| Using his or her hands, my child can use a computer mouse | 3.04 | −1.87 | −1.64 | −1.25 | −0.78 |
| My child can make the bed | 3.25 | −0.63 | −0.14 | 0.38 | 0.78 |
| My child can wash dishes | 2.87 | −0.57 | −0.28 | 0.20 | 0.68 |
| My child can hang a coat on a hook | 3.09 | −1.22 | −0.93 | −0.37 | 0.15 |
| My child can put a DVD or CD into the player | 4.82 | −1.26 | −1.12 | −0.91 | −0.54 |
| With two hands working together to grab the money, my child can take dollars out of a wallet or purse | 4.29 | −1.27 | −0.94 | −0.52 | −0.26 |
| My child can sweep the floor | 2.74 | −0.69 | −0.33 | 0.16 | 0.65 |
| My child can tighten screws and bolts on a wheelchair | 3.01 | −0.46 | −0.13 | 0.16 | 0.41 |
| My child can take clothes out of the washer and put them in the dryer | 2.26 | −0.24 | −0.03 | 0.37 | 0.78 |
| My child can use a hose outside to water plants | 2.50 | −1.10 | −0.87 | −0.30 | 0.21 |
| My child can try on clothes in a store dressing room | 2.57 | −0.48 | −0.06 | 0.43 | 0.85 |
| Using only one hand, my child can feed him or herself cookies or pretzels | 5.03 | −1.95 | −1.68 | −1.45 | −1.15 |
| After the toothpaste has been put on a toothbrush, using only one hand to hold the brush, my child can brush his or her teeth | 3.99 | −1.39 | −1.19 | −1.00 | −0.63 |
| With a universal cuff (u-cuff), my child can put chapstick on his or her lips | 2.59 | −1.58 | −1.33 | −0.87 | NA |
| With a wrist-hand splint, my child can feed him or herself cookies or pretzels | 2.27 | −2.67 | −1.90 | −1.25 | NA |
| Using both hands to hold the spoon, my child can use a spoon to eat soup | 3.78 | −1.23 | −0.94 | −0.81 | −0.52 |
| Using both hands to hold food, my child can feed him or herself cookies or pretzels | 3.19 | −1.67 | −1.47 | −1.29 | −0.96 |
| With a universal cuff (u-cuff) my child can use a fork to eat | 2.58 | −3.05 | −2.33 | −1.16 | NA |
| Using both hands to hold the fork, my child can use a fork to eat | 2.89 | −1.41 | −1.32 | −1.10 | −0.79 |
| Using a wrist-hand splint, my child can put chapstick on his or her lips | 1.89 | −1.55 | −1.25 | −0.95 | −0.60 |
| Using both of hands to hold the chapstick, my child can put chapstick on his or her lips | 3.09 | −1.34 | −1.18 | −0.98 | −0.63 |
| After the toothpaste has been put on a toothbrush, with a universal cuff (u-cuff) my child can brush his or her teeth | 1.86 | −2.95 | −2.50 | −1.79 | −1.01 |
| After the toothpaste has been put on a toothbrush, using both hands to hold the brush, my child can brush his or her teeth | 2.44 | −1.54 | −1.33 | −1.03 | −0.57 |
| Without any splints, my child can unzip a jacket | 3.06 | −1.06 | −0.88 | −0.51 | −0.11 |
| By squeezing the tube with both hands, my child can put toothpaste on a toothbrush | 4.84 | −1.19 | −0.96 | −0.66 | −0.33 |
| By squeezing the tube with only one hand, my child can put toothpaste on a toothbrush | 5.40 | −1.02 | −0.89 | −0.58 | −0.40 |
| With a universal cuff (u-cuff), my child can use a spoon to eat ice cream | 1.98 | −2.94 | −2.27 | −1.49 | −1.10 |
| After someone has helped with clothes and setup, using a wrist-hand splint, my child can catheterize him or herself | 1.80 | −0.82 | −0.08 | 0.37 | NA |
| After someone has helped with clothes and setup, using two hands to hold the catheter, my child can catheterize him or herself | 2.58 | −0.41 | −0.34 | −0.21 | 0.06 |
| After someone has helped with clothes and setup, using only one hand to hold the catheter, my child can catheterize him or herself | 2.76 | −0.41 | −0.30 | −0.13 | 0.11 |
| Using a wrist-hand splint, my child can brush his or her hair | 2.57 | −1.64 | −1.24 | −0.89 | −0.52 |
| Using two hands to hold the brush, my child can brush his or her hair | 4.19 | −1.22 | −0.95 | −0.71 | −0.30 |
| Using his or her mouth, my child can open a bag of chips | 2.22 | −1.41 | −1.03 | −0.65 | −0.17 |

(*continued on next page*)

**Supplemental Table S1** (*continued*)

| Daily Routine Domain (continued) | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| With a wrist-hand splint, my child can use a spoon to eat soup | 1.86 | −2.19 | −1.51 | −1.11 | −0.82 |
| My child can drink from a can without using a straw | 2.54 | −2.01 | −1.81 | −1.36 | −1.03 |
| With a universal cuff (u-cuff), my child can use a spoon to eat soup | 1.79 | −2.70 | −2.19 | −1.62 | −0.74 |
| Using a splint, my child can zip up a jacket | 2.65 | −0.86 | −0.56 | −0.42 | 0.36 |
| Including fixing clothes, setup, and cleanup, with a wrist-hand splint, my child can catheterize him or herself | 1.78 | −0.54 | −0.07 | 0.34 | 0.71 |
| Including fixing clothes, setup, and cleanup, with a splint, using both hands to hold the catheter, my child can catheterize him or herself | 2.06 | −0.54 | −0.11 | 0.14 | 0.41 |
| My child can put lotion on his or her face | 4.42 | −1.61 | −1.37 | −1.11 | −0.71 |
| My child can shake salt or pepper on food | 6.90 | −1.29 | −1.18 | −0.87 | −0.61 |
| My child can put ketchup on a plate | 6.53 | −1.13 | −1.02 | −0.76 | −0.44 |
| My child can take off daytime hand splints | 2.53 | −1.53 | −1.31 | −1.00 | −0.59 |
| When sitting in the seat of a car, my child can take a seat belt off | 4.43 | −0.98 | −0.87 | −0.77 | −0.45 |
| Using only one hand to hold the brush, my child can brush his or her hair | 4.79 | −1.19 | −0.97 | −0.57 | −0.41 |
| Using only one hand to hold the fork, my child can use a fork to eat | 4.91 | −1.55 | −1.41 | −1.16 | −0.80 |
| My child can take off a sweatshirt by pulling it over his or her head | 4.97 | −1.14 | −0.85 | −0.52 | −0.17 |
| My child can put on a hat | 5.98 | −1.53 | −1.35 | −1.07 | −0.77 |
| My child can put on a t-shirt (short sleeve pullover) | 4.32 | −1.56 | −1.15 | −0.73 | −0.31 |
| My child can put on a sweatshirt by pulling it over his or her head | 3.97 | −1.18 | −0.97 | −0.60 | −0.21 |
| When sitting in the seat of a car, my child can put a seat belt on | 5.16 | −0.73 | −0.57 | −0.45 | −0.14 |
| Using only one hand to hold the spoon, my child can use a spoon to eat soup | 5.09 | −1.49 | −1.14 | −1.02 | −0.67 |
| By squeezing the tube with his or her mouth, my child can put toothpaste on a toothbrush | 2.18 | −1.30 | −1.10 | −0.67 | −0.28 |
| My child can put on daytime hand splints | 2.47 | −0.61 | −0.53 | −0.36 | 0.08 |
| Using only one hand to hold the spoon, my child can use a spoon to eat ice cream | 6.11 | −1.51 | −1.28 | −1.11 | −0.78 |
| My child can wash his or her hair in the shower or bath | 3.17 | −1.01 | −0.83 | −0.47 | −0.15 |
| My child can dry his or her hair with a towel | 4.00 | −1.22 | −0.92 | −0.62 | −0.30 |
| Using a wrist-hand splint, my child can unzip a jacket | 2.36 | −1.25 | −0.79 | −0.14 | NA |
| My child can close a bottle by twisting the lid | 4.93 | −1.12 | −0.91 | −0.67 | −0.28 |
| Using his or her hands, my child can open a bag of chips | 5.00 | −0.96 | −0.79 | −0.45 | −0.16 |
| Using only one hand to hold the chapstick, my child can put chapstick on his or her lips | 5.55 | −1.34 | −1.23 | −1.04 | −0.66 |
| My child can zip up a jacket | 5.22 | −0.86 | −0.53 | −0.27 | 0.00 |
| My child can insert a straw into a juice box | 4.88 | −1.20 | −0.85 | −0.57 | −0.26 |
| My child can scratch his or her face | 3.49 | −2.22 | −2.03 | −1.69 | −1.11 |
| Without any splints, my child can unbutton a shirt | 3.09 | −0.59 | −0.35 | −0.19 | −0.10 |
| Without any splints, my child can button up a shirt | 3.06 | −0.59 | −0.27 | −0.19 | −0.10 |
| My child can check the skin on his or her bottom | 2.32 | −0.16 | 0.07 | 0.45 | 0.88 |
| My child can clean his or her upper body | 4.11 | −1.52 | −1.23 | −0.85 | −0.43 |
| My child can take off socks | 3.66 | −0.84 | −0.59 | −0.35 | 0.00 |
| My child can put on socks | 4.67 | −0.65 | −0.35 | −0.13 | 0.15 |
| My child can put on a belt | 3.81 | −0.48 | −0.20 | 0.11 | 0.40 |
| My child can take off gym shorts | 3.87 | −0.72 | −0.40 | −0.15 | 0.24 |
| My child can put on gym shorts | 3.83 | −0.63 | −0.33 | −0.08 | 0.30 |
| My child can take off sweatpants | 3.79 | −0.73 | −0.42 | −0.12 | 0.25 |
| My child can put on sweatpants | 3.87 | −0.66 | −0.34 | −0.02 | 0.27 |
| My child can rub his or her eyes | 3.62 | −2.09 | −1.91 | −1.72 | −1.14 |
| My child can take off his or her sneakers | 3.95 | −0.72 | −0.52 | −0.24 | 0.07 |
| My child can put on his or her sneakers | 4.09 | −0.46 | −0.25 | 0.00 | 0.29 |
| My child can take off jeans | 3.38 | −0.63 | −0.34 | 0.00 | 0.43 |

(*continued on next page*)

**Supplemental Table S1** (*continued*)

Daily Routine Domain (continued)

| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
|---|---|---|---|---|---|
| My child can put on jeans | 3.75 | −0.47 | −0.21 | 0.13 | 0.50 |
| Including fixing clothes, setup, and cleanup, without any splints, my child can complete his or her bowel program | 1.66 | 0.60 | NA | NA | NA |
| My child can wash his or her face | 4.40 | −1.88 | −1.55 | −1.11 | −0.73 |
| My child can clean his or her entire body in the shower or bath | 3.58 | −0.76 | −0.47 | −0.15 | 0.22 |
| My child can take off his or her leg braces | 2.34 | −0.84 | −0.48 | −0.11 | 0.31 |
| My child can put on his or her leg braces | 3.06 | −0.16 | −0.02 | 0.21 | 0.48 |
| My child can hook a zipper before pulling it up | 4.16 | −0.84 | −0.60 | −0.30 | 0.00 |
| With a wrist-hand splint, my child can use a spoon to eat ice cream | 1.78 | −2.75 | −2.14 | −1.35 | −1.06 |
| After the toothpaste has been put on a toothbrush, with a wrist-hand splint my child can brush his or her teeth | 2.38 | −2.27 | −2.00 | −1.44 | −0.87 |
| With a wrist-hand splint, my child can use a fork to eat | 2.08 | −2.97 | −1.82 | −1.33 | −0.92 |
| When sitting in the wheelchair, my child can fix the back of my shirt | 2.98 | −1.14 | −0.95 | −0.64 | −0.11 |
| My child can wipe his or her nose | 4.93 | −1.74 | −1.54 | −1.31 | −0.82 |
| My child can take off nighttime hand splints | 3.21 | −1.34 | −1.04 | −0.81 | −0.66 |
| When sitting in the wheelchair, my child can fix and straighten his or her pants | 3.36 | −0.98 | −0.65 | −0.15 | 0.31 |
| My child can put on a wheelchair pelvic belt | 3.57 | −1.06 | −0.88 | −0.61 | −0.34 |
| My child can take off a wheelchair pelvic belt | 2.91 | −1.25 | −1.10 | −0.84 | −0.47 |
| Once in bed, my child can pull up sheets and blankets | 3.52 | −1.49 | −1.04 | −0.65 | −0.32 |
| When sitting in the wheelchair, my child can bring a foot up, like when putting on socks or shoes | 2.56 | −0.52 | −0.30 | −0.01 | 0.31 |
| My child can dry his or her hair with a hair dryer | 3.90 | −0.76 | −0.57 | −0.23 | 0.00 |
| My child can take off his or her hat | 3.79 | −2.00 | −1.88 | −1.69 | −1.23 |
| My child can put on nighttime hand splints | 2.59 | −0.68 | −0.52 | −0.28 | 0.15 |
| With a splint, my child can unbutton a shirt | 2.52 | −0.51 | −0.27 | −0.10 | 0.26 |
| With a splint, my child can button up a shirt | 2.05 | −0.38 | 0.65 | NA | NA |
| Including fixing clothes, setup, and cleanup, with a splint, using only one hand to hold the catheter, my child can catheterize him or herself | 2.37 | −0.55 | 0.07 | 0.32 | 0.64 |
| Including fixing clothes, setup, and cleanup, with a hand splint, my child can complete his or her bowel program | 1.93 | −0.09 | 0.20 | 0.30 | 0.65 |

Wheeled Mobility Domain

| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
|---|---|---|---|---|---|
| In the manual wheelchair, my child can lock the brakes | 3.10 | −2.08 | −1.76 | −1.45 | −0.99 |
| My child can push the manual wheelchair while carrying a small object, such as a toy, in his or her lap | 3.27 | −2.21 | −1.81 | −1.18 | −0.55 |
| My child can push the manual wheelchair over a small bump in the floor | 6.00 | −1.79 | −1.52 | −1.00 | −0.41 |
| My child can push the manual wheelchair in a busy hallway with a lot of people | 4.70 | −1.76 | −1.43 | −0.84 | −0.36 |
| While carrying a glass of water in his or her lap, my child can push the manual wheelchair | 2.38 | −1.40 | −0.91 | −0.33 | 0.35 |
| In the manual wheelchair, my child can keep his or her place in a line of moving people. | 4.22 | −1.73 | −1.40 | −0.97 | −0.45 |
| In the manual wheelchair, my child can cross the street at a traffic light | 3.80 | −1.42 | −1.09 | −0.51 | −0.06 |
| My child can push the manual wheelchair down a ramp | 3.77 | −1.42 | −1.10 | −0.76 | −0.31 |
| My child can push the manual wheelchair up a ramp | 3.68 | −1.17 | −0.99 | −0.43 | 0.15 |
| My child can push the manual wheelchair all day in school | 4.55 | −1.31 | −1.05 | −0.74 | −0.29 |
| My child can push the wheels of a manual wheelchair | 4.06 | −1.96 | −1.44 | −1.02 | −0.63 |
| My child can push the manual wheelchair on grass outside | 3.38 | −1.14 | −0.49 | 0.06 | 0.79 |
| In the manual wheelchair, my child can pop a wheelie | 2.57 | −1.12 | −1.01 | −0.67 | −0.26 |

(*continued on next page*)

**Supplemental Table S1** (*continued*)

| Wheeled Mobility Domain (continued) | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| My child can push the manual wheelchair down a curb | 2.42 | −0.97 | −0.62 | −0.21 | 0.34 |
| In the manual wheelchair, my child can do a weight shift or pressure relief | 3.34 | −2.27 | −1.45 | −0.91 | NA |
| My child can push the manual wheelchair up a curb | 2.42 | −0.68 | −0.35 | 0.15 | 0.81 |
| In a wheelie position, my child can push the manual wheelchair | 2.94 | −0.59 | −0.37 | −0.08 | 0.19 |
| My child can put the manual wheelchair into the car | 2.08 | 0.36 | 0.51 | 0.87 | 1.10 |
| Before getting into bed, my child can put the manual wheelchair next to the bed | 2.80 | −1.42 | −1.36 | −1.09 | −0.67 |
| On a flat surface, my child can stop the manual wheelchair before he or she hits something | 5.03 | −2.38 | −1.68 | −1.28 | −0.75 |
| In the manual wheelchair, my child can sit without losing balance | 1.54 | −3.10 | −2.84 | −1.75 | −0.93 |
| For this question, hooking means to hold your arm to the wheelchair to keep your balance. My child can hook his or her arm on the manual wheelchair. | 1.85 | −1.91 | −1.67 | −1.45 | −0.99 |
| In the manual wheelchair, my child can lean forward to reach for something in front of him or her | 2.54 | −1.83 | −1.65 | −0.96 | −0.28 |
| My child can push the manual wheelchair out of an elevator | 6.54 | −1.84 | −1.69 | −1.25 | −0.83 |
| After reaching to the floor, my child can come back up to sit in the manual wheelchair | 2.67 | −1.21 | −0.96 | −0.53 | 0.13 |
| When sitting in the manual wheelchair, my child can put his or her feet on the footplates | 3.46 | −1.58 | −1.25 | −0.97 | −0.46 |
| My child can get out of the manual wheelchair and into bed | 3.34 | −1.32 | −1.01 | −0.59 | −0.16 |
| My child can push the manual wheelchair on mulch or gravel outside, like at a playground | 2.92 | −1.01 | −0.28 | 0.39 | 1.09 |
| When sitting in the manual wheelchair, my child can bend forward to pick something up from the floor | 2.98 | −1.27 | −1.11 | −0.61 | −0.01 |
| My child can push the manual wheelchair on a flat surface | 5.07 | −2.15 | −1.96 | −1.49 | −0.92 |
| From the manual wheelchair, my child can get into the seat of a car | 2.44 | −0.84 | −0.51 | −0.16 | 0.53 |
| From the seat of a car, my child can get into the manual wheelchair | 2.32 | −0.81 | −0.49 | −0.19 | 0.57 |
| From the floor, my child can get into the manual wheelchair | 2.31 | −0.38 | −0.02 | 0.37 | 0.78 |
| When sitting at the edge of the bed, my child can get into the manual wheelchair | 3.48 | −1.39 | −1.04 | −0.58 | −0.16 |
| In the manual wheelchair, my child can sit for 8 hours, like from morning to night or all day in school | 1.29 | −3.25 | −2.49 | −1.77 | −0.92 |
| My child can stop the manual wheelchair | 5.05 | −2.21 | −1.53 | −1.17 | −0.76 |
| When an adult is present, in my manual wheelchair, I can cross the street at a traffic light | 2.82 | −1.65 | −1.36 | −0.88 | −0.48 |
| My child can push the manual wheelchair through a room | 3.43 | −2.06 | −1.78 | −1.20 | −0.73 |
| In the manual wheelchair, my child can turn corners indoors without hitting the walls | 3.03 | −2.14 | −1.85 | −1.30 | −0.68 |
| My child can push the manual wheelchair on a rug | 3.31 | −1.89 | −1.39 | −0.81 | −0.12 |
| In the power wheelchair, my child can turn corners indoors without hitting the walls | 1.44 | −5.02 | −4.39 | −3.55 | −2.28 |
| In the power wheelchair, my child can keep his or her place in a line of moving people | 2.01 | −3.92 | −3.57 | −2.80 | NA |
| My child can move the power wheelchair out of an elevator | 2.12 | −3.95 | −3.63 | −3.03 | NA |
| My child can move the power wheelchair in the TV room of my house | 0.96 | −4.83 | −3.99 | −3.45 | NA |
| My child can turn the power wheelchair on | 1.82 | −3.19 | −3.06 | −2.82 | −2.45 |
| My child can move the power wheelchair in a busy hallway with a lot of people | 1.50 | −4.29 | −3.41 | −2.19 | NA |
| In the power wheelchair, my child can cross the street at a traffic light | 1.44 | −3.88 | −3.52 | −2.50 | NA |

(*continued on next page*)

**Supplemental Table S1** (*continued*)

| Wheeled Mobility Domain (continued) | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| In the power wheelchair, my child can sit without losing balance | 1.10 | −4.44 | −3.87 | −3.17 | −2.11 |
| For this question, hooking means to hold your arm to the wheelchair to keep your balance. My child can hook his or her arm on the power wheelchair. | 1.85 | −2.42 | −2.15 | −1.78 | NA |
| In the power wheelchair, my child can lean forward to reach for something in front of him or her | 1.38 | −2.26 | −1.99 | −1.36 | −0.68 |
| When sitting in the power wheelchair, my child can put his or her feet on the footplates | 1.77 | −1.28 | −1.07 | −0.80 | −0.57 |
| My child can get out of the power wheelchair and into bed | 2.46 | −0.80 | −0.54 | −0.28 | −0.13 |
| In the power wheelchair, my child can do a weight shift or pressure relief | 1.22 | −3.62 | −2.90 | −2.26 | NA |
| When sitting in the power wheelchair, my child can bend forward to pick something off the floor. | 2.34 | −0.82 | −0.60 | −0.29 | 0.22 |
| After reaching to the floor, my child can come back up to sit in the power wheelchair | 2.39 | −0.80 | −0.75 | −0.43 | −0.04 |
| From the power wheelchair, my child can get into the seat of a car | 1.74 | −0.09 | 0.07 | 0.33 | 0.43 |
| When an adult is present, in the power wheelchair, my child can cross the street at a traffic light | 0.87 | −4.09 | −3.49 | −2.64 | NA |
| In the power wheelchair, my child can sit for 4 hours, like from morning to lunch | 0.86 | −5.46 | −4.33 | −3.90 | NA |
| When sitting at the edge of the bed, my child can get into the power wheelchair | 2.37 | −0.95 | −0.54 | −0.20 | −0.05 |
| In the power wheelchair, my child can move on flat surfaces | 0.71 | −5.27 | −4.61 | −4.12 | −3.44 |
| In the power wheelchair, my child can sit for 8 hours, like from morning to night or all day in school | 0.75 | −6.03 | −5.07 | −3.85 | −3.52 |
| My child can move the power wheelchair down a ramp | 2.00 | −3.90 | −3.55 | −2.80 | NA |
| My child can move the power wheelchair onto a power lift | 1.51 | −3.16 | −3.05 | −2.55 | NA |
| Before getting into bed, my child can put the power wheelchair next to the bed | 0.97 | −2.90 | −2.70 | −2.61 | −2.17 |

Abbreviations: CD, compact disc; DVD, digital versatile disk; NA, not applicable; TV, television.

* Item discrimination parameter.

† Thresholds 1—4 are the threshold parameters; the values are increasing.

**Supplemental Table S2** Item parameters for each Ped SCI content domain (child version)

| Ambulation Domain | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination* | Threshold 1† | Threshold 2† | Threshold 3† | Threshold 4† |
| I can run | 2.14 | 0.34 | 0.56 | 1.00 | 1.67 |
| I can walk on a slippery surface, like a wet floor | 2.79 | −1.07 | −0.06 | 0.34 | 1.18 |
| I can walk while carrying a tray of food | 2.19 | −0.93 | −0.21 | 0.19 | 0.80 |
| I can walk and text on my phone | 1.36 | −0.91 | −0.71 | −0.02 | 0.58 |
| I can take a step with each foot | 1.66 | −2.95 | −2.22 | −1.64 | −0.20 |
| I can walk in therapy | 2.29 | −2.98 | −2.15 | −1.77 | −0.36 |
| I can walk from room to room in my home | 3.38 | −2.11 | −1.78 | −1.16 | −0.33 |
| I can walk out of an elevator | 3.47 | −1.84 | −1.55 | −1.14 | −0.38 |
| I can walk on grass outside | 3.48 | −1.48 | −1.03 | −0.37 | 0.26 |
| I can walk while carrying a shopping bag in one hand | 2.21 | −1.20 | −0.73 | 0.16 | 0.82 |
| I can walk on mulch or gravel outside, like at a playground | 2.73 | −1.29 | −0.81 | −0.06 | 0.66 |
| I can walk up a flight of stairs using the rail | 2.45 | −1.00 | −0.61 | −0.11 | 0.57 |
| I can walk down a flight of stairs using the rail | 2.17 | −0.98 | −0.63 | −0.27 | 0.45 |
| I can walk in a busy hallway with a lot of people | 2.66 | −1.28 | −0.81 | 0.01 | 0.74 |
| I can walk with a backpack on my back | 2.12 | −1.25 | −0.89 | −0.11 | 0.73 |
| I can step up a curb | 3.06 | −1.38 | −1.06 | −0.28 | 0.33 |
| I can step down a curb | 3.06 | −1.34 | −1.05 | −0.47 | 0.21 |
| I can walk in between a row of chairs, like at a movie theater | 2.64 | −1.99 | −1.08 | −0.40 | 0.40 |
| I can walk down steps to get off a bus | 2.23 | −0.59 | −0.24 | 0.10 | 0.75 |
| I can walk up a ramp or steep hill | 2.49 | −1.48 | −1.08 | −0.55 | 0.62 |
| I can walk down a ramp or steep hill | 2.33 | −1.55 | −1.06 | −0.39 | 0.79 |
| I can walk on a dirt path or hiking trail | 2.69 | −0.69 | −0.63 | 0.03 | 0.80 |
| I can walk and keep my place in a line of moving people | 2.58 | −1.35 | −1.09 | −0.29 | 0.42 |
| I can change direction by turning around while walking | 1.99 | −2.23 | −1.29 | −0.52 | 0.05 |
| I can walk up steps to enter a bus | 2.47 | −0.54 | −0.28 | 0.18 | 0.74 |
| **General Mobility Domain** | | | | | |
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| I push or pull the handle on a door | 1.97 | −2.32 | −2.11 | −1.69 | −0.68 |
| I can turn the knob on a door | 2.72 | −1.75 | −1.49 | −1.28 | −0.81 |
| I can sit on the edge of my bed | 2.46 | −2.16 | −1.79 | −1.50 | −0.98 |
| When I am in bed, I can roll from my back to my side | 3.23 | −1.88 | −1.33 | −1.09 | −0.63 |
| I can move from lying in bed to sitting at the edge. | 4.06 | −1.30 | −1.09 | −0.86 | −0.44 |
| In bed, I can get under the sheets | 2.50 | −1.76 | −1.48 | −1.21 | −0.64 |
| When sitting at the edge of my bed, I can lean forward to reach for something | 2.29 | −1.35 | −1.03 | −0.61 | 0.21 |
| Using my arms for support, I can sit on a picnic bench | 2.38 | −1.57 | −1.25 | −1.04 | −0.41 |
| I can hold a door open while moving into a room | 2.13 | −2.00 | −1.62 | −1.01 | −0.14 |
| When in my bed, I can roll from my back onto my belly | 3.20 | −1.32 | −1.07 | −0.83 | −0.38 |
| Bumping means to go down stairs on my bottom. I can bump down the stairs | 2.94 | −0.46 | −0.32 | −0.11 | 0.25 |
| Bumping means to go up the stairs on my bottom. I can bump up the stairs | 2.84 | −0.35 | −0.19 | 0.07 | 0.53 |
| I can move from sitting at the edge of the bed to lying down | 3.06 | −1.65 | −1.36 | −1.13 | −0.55 |
| Without using my arms for support, I can sit on a picnic bench | 2.12 | −1.13 | −0.81 | −0.36 | 0.18 |
| I can move on to a shower chair | 4.49 | −0.93 | −0.77 | −0.49 | −0.01 |
| I can move off a shower chair | 4.64 | −0.91 | −0.73 | −0.47 | 0.00 |
| I can move into a tub | 3.81 | −0.54 | −0.33 | −0.11 | 0.29 |
| I can move out of a tub | 3.37 | −0.46 | −0.21 | 0.02 | 0.46 |
| I can move on to a toilet | 6.99 | −0.67 | −0.47 | −0.22 | −0.03 |
| I can move off a toilet | 7.32 | −0.63 | −0.47 | −0.22 | 0.05 |

(*continued on next page*)

**Supplemental Table S2** (*continued*)

| Daily Routine Domain | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| With two hands, I can hold a ball | 1.81 | −2.73 | −2.46 | −2.03 | −1.46 |
| Using only one hand, I can feed myself cookies or pretzels | 3.28 | −2.01 | −1.91 | −1.68 | −1.45 |
| Using only one hand to hold the fork, I can use a fork to eat | 3.54 | −1.65 | −1.48 | −1.25 | −1.12 |
| Using only one hand to hold the spoon, I can use a spoon to eat ice cream | 4.53 | −1.53 | −1.40 | −1.24 | −1.01 |
| I can finger-paint | 1.72 | −2.31 | −2.09 | −1.63 | NA |
| I can scratch my face | 2.34 | −2.89 | −2.57 | −2.42 | −2.19 |
| Using only one hand, I can pour cereal | 4.31 | −0.93 | −0.73 | −0.58 | −0.27 |
| I can wash my hands at a sink with soap and water | 4.18 | −1.68 | −1.53 | −1.16 | −0.78 |
| I can dust a table | 2.59 | −2.06 | −1.79 | −1.40 | −0.98 |
| Using my hands, I can use a computer mouse | 2.84 | −2.13 | −1.87 | −1.56 | −1.26 |
| I can wash my face | 3.30 | −2.09 | −1.92 | −1.59 | −1.32 |
| I can put a DVD or CD into the player | 4.45 | −1.56 | −1.44 | −1.08 | −0.83 |
| I can wipe my nose | 2.73 | −2.34 | −2.20 | −1.96 | −1.71 |
| I can take off my hat | 2.68 | −2.37 | −2.19 | −2.01 | −1.78 |
| Using only one hand to hold the brush, I can paint with a paintbrush | 3.09 | −1.53 | −1.36 | −1.04 | −0.75 |
| After the toothpaste has been put on my toothbrush, using only one hand to hold the brush, I can brush my teeth | 3.12 | −1.68 | −1.49 | −1.27 | −1.10 |
| Using two hands, I can catch a ball | 2.42 | −1.90 | −1.56 | −1.12 | −0.72 |
| Using only one hand, I can set a table | 2.98 | −1.07 | −0.85 | −0.57 | −0.11 |
| I can drink from a can without using a straw | 2.96 | −1.89 | −1.81 | −1.55 | −1.23 |
| I can open hardcover books | 2.30 | −2.69 | −2.59 | −2.11 | −1.68 |
| I can put lotion on my face | 3.34 | −1.89 | −1.80 | −1.36 | −1.15 |
| Using all of my fingers, I can pick up Cheerios | 3.29 | −1.11 | −1.00 | −0.76 | −0.55 |
| I can shake salt or pepper on my food | 5.15 | −1.61 | −1.42 | −1.15 | −0.93 |
| Using two hands, I can throw a ball | 2.90 | −1.44 | −1.12 | −0.88 | −0.42 |
| I can pour ketchup onto my plate | 6.13 | −1.31 | −1.28 | −0.89 | −0.66 |
| I can take off my daytime hand splints | 2.39 | −1.82 | −1.62 | −1.38 | −1.08 |
| I can raise my hand in class | 1.85 | −3.11 | −2.94 | −2.41 | −1.73 |
| When sitting on the seat of a car, I can take my seat belt off | 4.78 | −1.30 | −1.12 | −0.96 | −0.67 |
| Using only one hand to hold the brush, I can brush my hair | 3.11 | −1.41 | −1.22 | −1.04 | −0.77 |
| Using only one hand to use a remote, I can change TV channels | 2.52 | −2.00 | −1.79 | −1.45 | −1.11 |
| I can take off my sweatshirt by pulling it over my head | 3.69 | −1.24 | −1.01 | −0.87 | −0.49 |
| I can press the button to take a picture with a camera | 4.02 | −1.34 | −1.06 | −0.91 | −0.69 |
| I can put on my hat | 4.53 | −1.86 | −1.60 | −1.34 | −1.01 |
| I can put on my t-shirt (short sleeve pullover) | 4.41 | −1.43 | −1.22 | −1.09 | −0.81 |
| Exercise means doing an activity like biking, swimming, or arm cycling for at least 20 minutes. I can exercise. | 1.35 | −2.25 | −1.80 | −1.18 | −0.25 |
| I can put on my sweatshirt by pulling it over my head | 3.84 | −1.25 | −1.12 | −0.88 | −0.58 |
| I can ride a bike using my arms | 1.34 | −0.77 | −0.66 | −0.42 | 0.07 |
| When sitting on the seat of a car, I can put my seat belt on | 6.70 | −1.09 | −0.97 | −0.74 | −0.45 |
| Using only one hand, I can use the video game controller | 2.14 | −1.23 | −1.01 | −0.62 | −0.21 |
| Using only one hand to hold the spoon, I can use a spoon to eat soup | 3.73 | −1.63 | −1.36 | −1.27 | −1.00 |
| Using my hands, I can keyboard | 2.58 | −2.01 | −1.82 | −1.44 | −0.97 |
| By squeezing the tube with my mouth, I can put toothpaste on a toothbrush | 1.65 | −1.82 | −1.55 | −1.19 | −0.64 |
| Using only one hand, I can put a puzzle piece into a puzzle | 3.00 | −1.65 | −1.40 | −1.16 | −0.80 |
| I can put on my daytime hand splints | 2.51 | −1.10 | −0.78 | −0.60 | −0.37 |
| I can wash my hair in the shower or bath | 2.67 | −1.31 | −1.14 | −0.89 | −0.49 |
| I can dry my hair with a towel | 2.87 | −1.58 | −1.43 | −1.10 | −0.78 |
| Using my wrist-hand splint, I can unzip my jacket | 2.06 | −1.34 | −1.07 | −0.42 | NA |
| I can close a soft drink bottle by twisting the lid | 4.74 | −1.36 | −1.17 | −0.97 | −0.68 |
| Using my hands, I can open a bag of chips | 4.99 | −0.91 | −0.73 | −0.57 | −0.34 |
| Using only one hand to hold the chapstick, I can put chapstick on my lips | 3.48 | −1.39 | −1.31 | −1.10 | −0.93 |

(*continued on next page*)

**Supplemental Table S2** (*continued*)

| Daily Routine Domain (continued) | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| Using only one hand to hold the pen, I can draw a picture of a person | 2.88 | −1.50 | −1.27 | −1.00 | −0.75 |
| I can zip up my jacket | 4.88 | −1.08 | −0.88 | −0.58 | −0.30 |
| Using both hands to hold the marker, at school, I can write on the board | 2.38 | −1.44 | −1.35 | −0.95 | −0.52 |
| I can insert a straw into a juice box | 4.53 | −1.29 | −1.20 | −0.82 | −0.60 |
| Without any splints, I can unbutton my shirt | 3.45 | −0.89 | −0.22 | −0.03 | NA |
| Without using any splints, I can button up my shirt | 3.58 | −0.89 | −0.10 | 0.39 | NA |
| Using just my hands, I can open a cereal box | 4.79 | −1.10 | −0.94 | −0.72 | −0.55 |
| With my mouth, I can turn the pages of a book | 0.61 | −2.56 | −2.16 | −1.48 | −0.57 |
| I can check my skin on my bottom | 3.00 | −0.34 | −0.15 | 0.08 | 0.46 |
| I can take a book out of my book bag | 5.37 | −1.14 | −0.92 | −0.62 | −0.36 |
| I can clean my upper body | 3.71 | −1.65 | −1.52 | −1.22 | −0.97 |
| I can swing a baseball bat | 2.52 | −1.04 | −0.68 | −0.33 | 0.03 |
| I can take off my socks | 5.05 | −0.85 | −0.70 | −0.51 | −0.30 |
| I can put on my socks | 5.80 | −0.65 | −0.53 | −0.37 | −0.15 |
| I can put on a belt | 4.55 | −0.52 | −0.40 | −0.29 | 0.07 |
| I can make popcorn in the microwave | 4.30 | −1.13 | −0.95 | −0.71 | −0.44 |
| I can take off gym shorts | 4.66 | −0.64 | −0.50 | −0.33 | −0.10 |
| I can take clean clothes out of the dryer | 3.00 | −0.85 | −0.67 | −0.39 | 0.10 |
| I can put on gym shorts | 4.12 | −0.66 | −0.46 | −0.30 | −0.01 |
| I can draw a line using a ruler | 3.44 | −1.58 | −1.34 | −1.13 | −0.83 |
| I can take off sweatpants | 4.91 | −0.68 | −0.50 | −0.34 | −0.10 |
| Using just my hands, I can remove the cap from a marker | 4.06 | −1.13 | −0.90 | −0.67 | −0.44 |
| I can put on sweatpants | 4.26 | −0.67 | −0.46 | −0.28 | −0.02 |
| After the food is given to me, without any hand splints, I can make a sandwich | 3.12 | −1.16 | −0.86 | −0.66 | −0.41 |
| I can take off my sneakers | 4.67 | −0.80 | −0.63 | −0.48 | −0.28 |
| I can put on my sneakers | 4.92 | −0.58 | −0.48 | −0.36 | −0.11 |
| Using only one hand, I can move a board game piece | 3.07 | −2.44 | −1.99 | −1.66 | −1.23 |
| I can take off jeans | 4.50 | −0.62 | −0.36 | −0.18 | 0.06 |
| I can put on jeans | 4.01 | −0.56 | −0.28 | −0.10 | 0.15 |
| I can cut with scissors | 4.97 | −0.96 | −0.72 | −0.57 | −0.38 |
| Including fixing my clothes, setup, and cleanup, without any splints, I can complete my bowel program | 1.74 | −0.01 | 0.48 | 0.90 | 1.73 |
| I can clean my entire body in the shower or bath | 4.54 | −0.72 | −0.47 | −0.28 | 0.09 |
| I can get a snack from the vending machine | 5.21 | −1.08 | −0.79 | −0.60 | −0.35 |
| I can take off my leg braces | 3.11 | −0.97 | −0.61 | −0.29 | 0.00 |
| I can make the bed | 3.25 | −0.69 | −0.51 | −0.10 | 0.45 |
| I can put on my leg braces | 2.53 | −0.59 | −0.28 | −0.14 | 0.29 |
| I can hook my zipper before pulling it up | 4.59 | −0.94 | −0.79 | −0.56 | −0.33 |
| With my wrist-hand splint, I can use a spoon to eat ice cream | 1.63 | −1.55 | −1.21 | NA | NA |
| After the toothpaste has been put on my toothbrush, with my wrist-hand splint I can brush my teeth | 1.86 | −2.18 | −1.46 | NA | NA |
| With my wrist-hand splint, I can use a fork to eat | 1.45 | −2.68 | −2.14 | −1.77 | NA |
| I can wash dishes | 3.44 | −0.80 | −0.60 | −0.29 | 0.08 |
| I can hang my coat on a hook | 3.66 | −1.26 | −0.98 | −0.63 | −0.26 |
| When sitting in my wheelchair, I can fix the back of my shirt | 4.10 | −1.20 | −1.02 | −0.73 | −0.23 |
| With two hands working together to grab the money, I can take dollars out of my wallet or purse | 3.79 | −1.51 | −1.31 | −0.96 | −0.63 |
| I can take off my nighttime hand splints | 2.31 | −1.83 | −1.72 | −1.37 | −0.91 |
| I can put away clean dishes | 2.91 | −0.67 | −0.50 | −0.16 | 0.29 |
| While my shoes are on my feet, I can tie my shoes | 4.92 | −0.40 | −0.31 | −0.17 | 0.05 |
| I can sweep the floor | 2.68 | −0.89 | −0.62 | −0.27 | 0.48 |
| I can put on my wheelchair pelvic belt | 3.41 | −1.17 | −1.08 | −0.99 | −0.68 |

(*continued on next page*)

**Supplemental Table S2** (*continued*)

| Daily Routine Domain (continued) | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| I can take off my wheelchair pelvic belt | 2.91 | −1.46 | −1.24 | −1.09 | −0.85 |
| I can pour from a large bottle of milk | 3.98 | −0.85 | −0.66 | −0.37 | 0.02 |
| Once in bed, I can pull up my sheets and blankets | 2.75 | −1.80 | −1.59 | −1.09 | −0.65 |
| When sitting in my wheelchair, I can bring my foot up, like when I put on socks or shoes | 2.96 | −0.61 | −0.38 | −0.24 | 0.06 |
| I can dry my hair with a hair dryer | 3.82 | −0.97 | −0.87 | −0.58 | −0.35 |
| I can tighten screws and bolts on a wheelchair | 2.63 | −0.56 | −0.42 | −0.20 | 0.26 |
| I can put on my nighttime hand splints | 2.95 | −1.04 | −0.61 | −0.51 | NA |
| With my splint, I can unbutton my shirt | 2.63 | −0.84 | 0.04 | 0.29 | NA |
| With my splint, I can button up my shirt | 2.89 | −0.81 | −0.28 | −0.01 | 0.20 |
| I can take clothes out of the washer and put them in the dryer | 2.89 | −0.51 | −0.40 | −0.08 | 0.33 |
| Including fixing my clothes, setup, and cleanup, with my splint, using only one hand to hold the catheter, I can catheterize myself | 2.60 | −0.50 | −0.13 | 0.06 | 0.28 |
| Including fixing my clothes, setup, and cleanup, with my hand splint, I can complete my bowel program | 1.67 | −0.23 | 0.36 | 0.64 | 1.05 |
| I can use a hose outside to water plants | 2.49 | −1.12 | −0.88 | −0.51 | 0.05 |
| I can try on clothes in a store dressing room | 2.73 | −0.50 | −0.32 | 0.10 | 0.55 |
| With my universal cuff (u-cuff), I can put chapstick on my lips | 1.92 | −2.14 | −1.98 | −1.42 | −0.87 |
| Using only one hand, I can take coins out of my wallet or purse | 3.85 | −1.24 | −0.89 | −0.76 | −0.41 |
| With my wrist-hand splint, I can feed myself cookies or pretzels | 1.68 | −1.82 | −1.46 | NA | NA |
| Using one hand, I can throw a ball | 2.96 | −1.60 | −1.26 | −0.90 | −0.49 |
| Using both of my hands to hold food, I can feed myself cookies or pretzels | 2.91 | −1.77 | −1.72 | −1.61 | −1.33 |
| Using one hand, I can catch a ball | 2.88 | −1.18 | −0.77 | −0.53 | −0.07 |
| With my universal cuff (u-cuff) I can use a fork to eat | 1.80 | −3.04 | −2.59 | −2.08 | NA |
| Using my mouth, I can remove a marker cap | 1.24 | −3.76 | −3.24 | −2.59 | −1.81 |
| Using both my hands to hold the fork, I can use a fork to eat | 2.70 | −1.50 | −1.39 | −1.15 | −0.75 |
| With one hand, I can hold a ball | 2.07 | −1.47 | −1.26 | −1.07 | −0.62 |
| Using my wrist—hand splint, I can put chapstick on my lips | 1.35 | −2.03 | −1.01 | −0.64 | NA |
| Without my hand splints and without using my mouth, I can unwrap a chocolate bar | 3.36 | −1.18 | −0.95 | −0.74 | −0.51 |
| Using both of my hands to hold the chapstick, I can put chapstick on my lips | 2.59 | −1.62 | −1.53 | −1.27 | −0.92 |
| I can wrap a gift with paper | 3.47 | −1.07 | −0.82 | −0.54 | −0.20 |
| After the toothpaste has been put on my toothbrush, with my universal cuff (u-cuff) I can brush my teeth | 1.17 | −2.78 | −2.48 | −2.04 | −0.91 |
| Using only one hand, I can pick up a playing card from the pile | 3.15 | −1.97 | −1.60 | −1.25 | −0.88 |
| After the toothpaste has been put on my toothbrush, using both of my hands to hold the brush, I can brush my teeth | 2.58 | −1.41 | −1.23 | −1.15 | −0.76 |
| Without any splints, I can unzip my jacket | 3.04 | −1.33 | −1.06 | −0.68 | −0.17 |
| Using my universal cuff, (u-cuff), I can paint with a paintbrush | 1.16 | −3.90 | −2.83 | −1.26 | NA |
| By squeezing the tube with both of my hands, I can put toothpaste on a toothbrush | 4.05 | −1.44 | −1.33 | −1.03 | −0.70 |
| Using my hand splints and not my mouth, I can remove the cap from a marker | 1.71 | −1.69 | −1.34 | −0.68 | −0.30 |
| By squeezing the tube with only one hand, I can put toothpaste on a toothbrush | 4.81 | −1.07 | −0.89 | −0.68 | −0.48 |
| With my hand splints and not my mouth, I can unwrap a chocolate bar | 1.64 | −1.33 | −0.83 | −0.60 | −0.09 |
| With my universal cuff (u-cuff), I can use a spoon to eat ice cream | 1.29 | −3.58 | −2.61 | −1.70 | NA |
| With my wrist—hand splint, I can move a board game piece | 1.41 | −1.98 | −1.65 | −0.96 | NA |
| Using both hands to hold the spoon, I can use a spoon to eat ice cream | 2.26 | −1.37 | −1.16 | −1.05 | −0.70 |
| With my wrist—hand splint, I can use a remote to change TV channels | 1.91 | −2.68 | −2.19 | −1.23 | −0.96 |

(*continued on next page*)

**Supplemental Table S2** (*continued*)

| Daily Routine Domain (continued) | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| After someone has helped with my clothes and setup, using my wrist-hand splint, I can catheterize myself | 1.37 | −1.69 | −0.39 | 0.83 | NA |
| With my wrist-hand splint, I can pick up Cheerios using my fingers | 1.38 | −1.59 | −0.54 | NA | NA |
| After someone has helped with my clothes and setup, using two hands to hold the catheter, I can catheterize myself | 2.83 | −0.60 | −0.53 | −0.35 | −0.17 |
| With my wrist-hand splint, I can pick up a playing card from the pile | 1.68 | −1.60 | −1.27 | −0.94 | NA |
| After someone has helped with my clothes and setup, using only one hand to hold the catheter, I can catheterize myself | 2.93 | −0.62 | −0.49 | −0.39 | −0.17 |
| With my wrist-hand splint, I can put a puzzle piece into a puzzle | 2.26 | −1.82 | −1.24 | −0.71 | NA |
| Using my wrist-hand splint, I can brush my hair | 2.35 | −1.82 | −1.24 | −0.71 | NA |
| With my wrist-hand splint, I can wrap a gift with paper | 2.51 | −1.36 | −0.54 | −0.13 | 0.37 |
| Using two hands to hold the brush, I can brush my hair | 3.22 | −1.31 | −1.05 | −0.92 | −0.60 |
| With my wrist-hand splint, I can pour cereal | 2.25 | −1.10 | −0.43 | NA | NA |
| With my wrist-hand splint, I can use a spoon to eat soup | 1.45 | −2.21 | −1.78 | NA | NA |
| With my wrist-hand splint, I can use the video game controller | 1.21 | −2.45 | −1.96 | −0.85 | −0.50 |
| With my universal cuff (u-cuff), I can use a spoon to eat soup | 1.18 | −2.72 | −1.96 | −1.57 | NA |
| With my mouth, I can open a cereal box | 1.41 | −1.66 | −1.47 | −0.82 | −0.37 |
| Using my splint, I can zip up my jacket | 2.87 | −1.40 | −1.15 | −0.88 | −0.32 |
| With my splint, I can put a DVD or CD into the player | 2.54 | −1.74 | −1.21 | −1.00 | −0.92 |
| Including fixing my clothes, setup, and cleanup, with my wrist-hand splint, I can catheterize myself | 1.84 | −1.08 | 0.04 | 0.63 | NA |
| Using my mouth to hold the pen, I can draw a picture of a person | 0.61 | −2.32 | −1.57 | −0.49 | 0.37 |
| Including fixing my clothes, setup, and cleanup, with my splint, using both of my hands to hold the catheter, I can catheterize myself | 2.50 | −0.84 | −0.57 | −0.10 | 0.07 |
| With my wrist-hand splint, at school I can write on the board | 1.07 | −3.10 | −0.43 | NA | NA |
| With my wrist-hand splint, I can set a table | 2.19 | −1.55 | −0.99 | 0.42 | NA |
| With my mouth, I can draw a line using a ruler | 0.87 | −1.95 | −1.25 | −0.28 | 0.61 |
| After the food is given to me, with my wrist-hand splint, I can make a sandwich | 2.60 | −1.55 | −1.06 | −0.48 | NA |
| With my hand splint, I can take dollars out of my wallet or purse | 2.60 | −1.40 | −1.10 | −0.57 | −0.43 |
| With my hand splint, I can take coins out of my wallet or purse | 2.61 | −1.36 | −1.04 | −0.79 | 0.04 |
| Using only my mouth, I can paint with a paintbrush | 0.68 | −3.78 | −3.18 | −2.42 | −1.29 |
| Using my wrist-hand splint, I can paint with a paintbrush | 1.13 | −1.96 | −1.56 | −1.19 | NA |
| Using both of my hands together to hold the brush, I can paint with a paintbrush | 2.44 | −1.78 | −1.48 | −1.14 | −0.66 |
| Using my mouth, I can unwrap a chocolate bar | 1.62 | −2.49 | −2.22 | −1.70 | −1.17 |
| Using my mouth, I can move a board game piece | 0.96 | −2.26 | −2.06 | −1.50 | −1.04 |
| Using both of my hands together, I can move a board game piece | 1.91 | −2.20 | −1.81 | −1.59 | −1.02 |
| Using two hands together to use a remote, I can change TV channels | 2.08 | −2.08 | −1.94 | −1.63 | −1.36 |
| Using just my pointer finger and thumb, I can pick up Cheerios | 2.69 | −1.68 | −1.54 | −1.15 | −0.96 |
| Using two hands together, I can pick up a playing card from the pile | 2.31 | −1.70 | −1.55 | −1.24 | −0.88 |
| Using two hands to hold the puzzle, I can put a puzzle piece into a puzzle | 2.74 | −1.38 | −1.26 | −1.01 | −0.71 |
| Using both of my hands together, I can turn the pages of a book | 1.97 | −2.19 | −2.10 | −1.72 | −1.31 |
| Using only one hand, I can turn the pages of a book | 2.73 | −2.21 | −2.04 | −1.87 | −1.41 |
| Using two hands together to hold the box, I can pour cereal | 4.03 | −1.32 | −1.09 | −0.82 | −0.51 |
| Using both of my hands together, I can use the video game controller | 2.80 | −1.63 | −1.46 | −1.16 | −0.76 |
| With my wrist-hand splint, I can draw a picture of a person | 1.12 | −2.42 | −1.98 | −0.85 | 0.00 |
| With my universal cuff (u-cuff) I can draw a picture of a person | 1.52 | −2.09 | −1.12 | −0.97 | −0.44 |
| Using both hands together to hold the pen, I can draw a picture of a person | 2.27 | −1.55 | −1.40 | −0.96 | −0.52 |

(*continued on next page*)

**Supplemental Table S2** (*continued*)

Daily Routine Domain (continued)

| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
|---|---|---|---|---|---|
| Using only one hand to hold the marker, at school, I can write on the board | 4.09 | −1.34 | −1.13 | −0.86 | −0.68 |
| Using both hands together, I can set the table | 3.85 | −0.97 | −0.78 | −0.52 | −0.24 |
| With my wrist-hand splint, I can draw a line using a ruler | 1.58 | −2.21 | −1.53 | −0.64 | NA |
| With my universal cuff (u-cuff), I can draw a line using a ruler | 1.60 | −2.47 | −1.48 | −1.22 | −0.01 |
| Without any hand splints, I can draw a line using a ruler | 3.93 | −1.20 | −0.93 | −0.59 | NA |
| Using only one hand to grab money, I can take dollars out of my wallet or purse | 3.18 | −1.24 | −1.10 | −0.89 | −0.56 |
| With two hands working together to grab the coins, I can take coins out of my wallet or purse | 3.81 | −1.33 | −1.02 | −0.79 | −0.46 |
| Using both of my hands to hold the spoon, I can use a spoon to eat soup | 2.39 | −1.39 | −1.22 | −1.08 | −0.85 |
| Using my mouth, I can open a bag of chips | 2.10 | −1.51 | −1.33 | −1.10 | −0.65 |
| When sitting in my wheelchair, I can fix and straighten my pants | 3.25 | −0.99 | −0.72 | −0.32 | 0.02 |

Wheeled Mobility Domain

| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
|---|---|---|---|---|---|
| In my manual wheelchair, I can lock the brakes | 2.17 | −2.82 | −2.69 | −2.42 | −1.69 |
| I can push the wheels of a manual wheelchair | 3.26 | −2.70 | −2.14 | −1.63 | −1.16 |
| On a flat surface, I can stop my manual wheelchair before I hit something | 2.41 | −2.98 | −2.78 | −2.62 | −1.58 |
| I can push my manual wheelchair on a flat surface | 2.06 | −3.09 | −2.77 | −2.56 | −2.11 |
| I can push my manual wheelchair through a room | 2.56 | −2.97 | −2.51 | −2.04 | −1.51 |
| In my manual wheelchair, I can turn corners indoors without hitting the walls | 2.50 | −2.73 | −2.60 | −2.23 | −1.24 |
| I can push my manual wheelchair on a rug | 2.35 | −2.53 | −1.92 | −1.41 | −0.59 |
| I can push my manual wheelchair while carrying a small object, such as a toy, in my lap | 1.92 | −2.70 | −2.60 | −1.99 | −1.04 |
| I can push my manual wheelchair over a small bump in the floor | 2.84 | −2.59 | −2.47 | −1.73 | −1.09 |
| I can push my manual wheelchair in a busy hallway with a lot of people | 2.06 | −2.90 | −2.30 | −1.72 | −0.91 |
| In my manual wheelchair, I can keep my place in a line of moving people. | 2.15 | −2.63 | −2.30 | −1.77 | −1.08 |
| In my manual wheelchair, I can cross the street at a traffic light | 2.69 | −1.88 | −1.56 | −0.97 | −0.36 |
| I can push my manual wheelchair down a ramp | 2.33 | −2.13 | −1.82 | −1.44 | −1.06 |
| I can push my manual wheelchair up a ramp | 2.77 | −1.70 | −1.31 | −0.91 | −0.05 |
| I can push my manual wheelchair all day in school | 3.32 | −1.80 | −1.46 | −1.23 | −0.70 |
| I can push my manual wheelchair on grass outside | 2.85 | −1.65 | −1.11 | −0.44 | 0.44 |
| In my manual wheelchair, I can pop a wheelie | 2.53 | −1.52 | −1.33 | −1.09 | −0.75 |
| I can push my manual wheelchair down a curb | 1.68 | −1.36 | −1.11 | −0.60 | 0.10 |
| In my manual wheelchair, I can do a weight shift or pressure relief | 1.79 | −2.85 | −2.75 | −2.38 | −1.76 |
| I can push my manual wheelchair up a curb | 1.91 | −0.92 | −0.65 | −0.04 | 0.73 |
| In a wheelie position, I can push my manual wheelchair | 1.79 | −1.04 | −0.82 | −0.46 | −0.03 |
| Before getting into bed, I can put my manual wheelchair next to the bed | 1.90 | −1.99 | −1.94 | −1.79 | −1.53 |
| In my manual wheelchair, I can sit without losing my balance | 0.97 | −4.77 | −3.98 | −3.08 | −1.98 |
| For this question, hooking means to hold your arm to the wheelchair to keep your balance. I can hook my arm on my manual wheelchair. | 1.28 | −3.17 | −2.90 | −2.35 | −1.82 |
| In my manual wheelchair, I can lean forward to reach for something in front of me | 1.58 | −2.66 | −2.43 | −1.89 | −0.94 |
| I can push my manual wheelchair out of an elevator | 3.82 | −2.46 | −2.17 | −1.84 | −1.57 |
| After reaching to the floor, I can come back up to sit in the manual wheelchair | 1.50 | −1.95 | −1.67 | −1.37 | −0.50 |
| When sitting in my manual wheelchair, I can put my feet on the footplates | 2.29 | −2.32 | −1.93 | −1.63 | −1.18 |

(*continued on next page*)

**Supplemental Table S2** (*continued*)

| Wheeled Mobility Domain (continued) | | | | | |
|---|---|---|---|---|---|
| Item | Discrimination | Threshold 1 | Threshold 2 | Threshold 3 | Threshold 4 |
| I can get out of my manual wheelchair and into my bed | 3.08 | −1.69 | −1.30 | −0.94 | −0.45 |
| I can push my manual wheelchair on mulch or gravel outside, like at a playground | 2.12 | −1.63 | −0.99 | −0.32 | 0.72 |
| When sitting in my manual wheelchair, I can bend forward to pick something up from the floor | 2.31 | −1.76 | −1.49 | −1.10 | −0.56 |
| From my manual wheelchair, I can get into the seat of a car | 2.44 | −1.22 | −0.90 | −0.62 | 0.10 |
| From the seat of a car, I can get into my manual wheelchair | 2.57 | −1.14 | −0.88 | −0.56 | 0.02 |
| From the floor, I can get into my manual wheelchair | 1.93 | −0.31 | −0.05 | 0.34 | 0.71 |
| When sitting at the edge of my bed, I can get into my manual wheelchair | 3.06 | −1.67 | −1.36 | −1.13 | −0.59 |
| In my manual wheelchair, I can sit for 8 hours, like from morning to night or all day in school | 0.83 | −4.67 | −3.91 | −3.40 | −2.29 |
| I can put my manual wheelchair into the car | 2.08 | −0.02 | 0.23 | 0.69 | 1.07 |
| When an adult is present, in my manual wheelchair, I can cross the street at a traffic light | 2.09 | −1.47 | −0.89 | NA | NA |
| I can turn my power wheelchair on | 1.16 | −4.20 | −4.03 | −3.75 | −3.30 |
| In my power wheelchair, I can do a weight shift or pressure relief | 0.94 | −3.90 | −3.77 | −3.33 | −3.07 |
| In my power wheelchair, I can move on flat surfaces | 0.90 | −5.05 | −4.78 | −4.55 | −4.36 |
| I can move my power wheelchair down a ramp | 1.56 | −4.61 | −4.07 | −3.88 | NA |
| I can move my power wheelchair onto a power lift | 1.32 | −4.00 | −3.85 | −3.48 | −3.19 |
| Before getting into bed, I can put my power wheelchair next to the bed | 0.77 | −4.66 | −4.49 | −3.91 | −3.46 |
| In my power wheelchair, I can turn corners indoors without hitting the walls | 0.95 | −5.37 | −4.52 | −3.13 | NA |
| In my power wheelchair, I can keep my place in a line of moving people | 1.40 | −4.23 | −4.03 | −3.58 | NA |
| I can move my power wheelchair out of an elevator | 1.58 | −4.29 | −4.05 | −3.87 | −3.46 |
| I can move my power wheelchair in the TV room of my house | 1.26 | −4.90 | −4.55 | −4.30 | NA |
| I can move my power wheelchair in a busy hallway with a lot of people | 1.23 | −4.49 | −4.27 | −3.46 | −2.79 |
| In my power wheelchair, I can cross the street at a traffic light | 1.07 | −5.77 | −4.35 | −3.48 | NA |
| In my power wheelchair, I can sit without losing my balance | 0.89 | −5.16 | −4.65 | −3.62 | NA |
| For this question, hooking means to hold your arm to the wheelchair to keep your balance. I can hook my arm on my power wheelchair. | 2.66 | −2.85 | −2.78 | −2.58 | −2.29 |
| In my power wheelchair, I can lean forward to reach for something in front of me | 1.40 | −2.93 | −2.49 | −2.04 | −1.44 |
| When sitting in my power wheelchair, I can put my feet on the footplates | 1.68 | −2.36 | −2.06 | −1.69 | −1.40 |
| I can get out of my power wheelchair and into my bed | 2.25 | −1.45 | −1.08 | −0.57 | −0.29 |
| When sitting in my power wheelchair, I can bend forward to pick something off the floor. | 2.09 | −0.99 | −0.73 | −0.22 | NA |
| After reaching to the floor, I can come back up to sit in my power wheelchair | 2.12 | −1.44 | −1.34 | −1.04 | −0.77 |
| From my power wheelchair, I can get into the seat of a car | 1.74 | −0.96 | −0.74 | −0.13 | 0.40 |
| In my power wheelchair, I can sit for 4 hours, like from morning to lunch | 0.94 | −4.92 | −4.66 | −4.44 | NA |
| In my power wheelchair, I can sit for 8 hours, like from morning to night or all day in school | 0.77 | −6.48 | −5.93 | −4.98 | −3.95 |
| When sitting at the edge of my bed, I can get into the power wheelchair | 2.32 | −1.33 | −0.91 | −0.40 | −0.14 |
| When an adult is present, in my power wheelchair, I can cross the street at a traffic light. | 0.88 | −2.80 | −2.36 | NA | NA |

Abbreviations: CD, compact disc; DVD, digital versatile disk; NA, not applicable; TV, television.

* Item discrimination parameter.

† Thresholds 1–4 are the threshold parameters; the values are increasing.