Cross-cultural adaptation and validation of the Ukrainian version of the ABILHAND-Kids questionnaire

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ABSTRACT

Purpose: To develop and cross-culturally validate the Ukrainian version of the ABILHAND-Kids questionnaire by testing its psychometric properties in a sample of Ukrainian children with cerebral palsy.

Methods: The ABILHAND-Kids questionnaire was translated into Ukrainian, cross-culturally adapted, and administered to 113 parents of children with cerebral palsy. The psychometric properties of the Ukrainian version and its cross-cultural validation were investigated through the Rasch rating scale model.

Results: One major misfit has been found for the item “Rolling up a sleeve of a sweater” that further was removed. The item “Putting on a backpack/schoolbag” was split into gender-specific items, separately for girls and for boys, as it was systematically easier for Ukrainian girls. All remaining items contributed to the definition of a unidimensional measure of manual ability. The internal consistency reliability of the scale was high ($R = 0.95$). No significant floor (4%) and ceiling effects (5%) were observed. Three major differential item functioning items were found across Belgium and Ukraine, highlighting the need to use the Ukrainian calibration of ABILHAND-Kids in Ukraine.

Conclusion: The Ukrainian ABILHAND-Kids questionnaire has good psychometric properties for assessing manual ability in Ukrainian children with cerebral palsy, holding potential to be implemented in clinical practice nationwide.

IMPLICATIONS FOR REHABILITATION

- Cerebral palsy impairs manual ability leading to decreased quality of life and participation.
- Professionals need valid and reliable tools to detect small changes of manual ability during rehabilitation.
- Metric properties and availability of the Ukrainian version of the ABILHAND-Kids questionnaire make it a useful tool in the assessment of children with cerebral palsy.

Introduction

Cerebral palsy (CP) is the leading cause of childhood disability worldwide, occurring in 2.1 per 1000 [1]. In more than half of children with CP, an impaired manual ability is one of the key reasons of reduced quality of life, highlighting the importance of interventions that aim to improve this particular aspect of physical ability [2].

The manual ability can be defined as “the capacity to manage daily activities requiring the use of the upper limbs, whatever the strategies involved” [3]. Besides motor skills and coordination, it also depends on cognitive abilities and motivation of a child [4]. Manual ability predominantly refers to the self-care sub-category (washing oneself, caring for body parts, toileting, dressing, eating, drinking, looking after one’s health) of the activity domain of the International Classification of Functioning, Disability and Health (ICF) [5] which can be defined as the execution of a task or an action by an individual. The activity ICF domain also includes the mobility (lifting & carrying objects, fine hand used, walking, moving around using equipment, using transportation, driving) and domestic life (acquisition of goods and services, preparation of meals, doing housework, assisting others) sub-categories. As many of the existing treatments aim to improve the child’s manual ability [6], measuring self-care performance is thus fundamental. Some of these functional interventions (e.g., constraint-induced movement therapy, hand-arm bimanual intensive therapy) have already shown promising results [7,8].

Clinicians need valid and reliable instruments to track improvement of manual ability during rehabilitation. One of the few tools, available in Ukraine to measure manual ability, is the Manual Ability Classification System (MACS) [9]. However, it is not suitable for quantitative measurement as it is a classification tool. According to recent systematic reviews [10,11], two bimanual performance measures were found to have excellent psychometric properties and clinical utility. The first tool is the Assisting Hand Assessment, an observational measure of how effectively children with a unilateral disability use their affected hand in bimanual activities [12–14]. Although the Assisting Hand Assessment predominantly measures the activity domain of the ICF, it captures the mobility subdomain rather than the self-care subdomain [15]. The second tool, which captures the self-care subdomain of the ICF, is ABILHAND-Kids, a parent-report questionnaire measuring a child’s capacity to handle everyday manual activities [16].
ABILHAND-Kids was rigorously developed using the Rasch model [17] which allows to verify if the scale meets the requirements of an objective measurement [16]. ABILHAND-Kids demonstrated good construct validity, internal consistency reliability (0.94), test-retest reliability (0.91), interrater reliability, and exhibited responsiveness in detecting changes after intensive training [16,18,19]. In addition to the established psychometric qualities, the accessibility, ease to use, and quickness-to-administer have made ABILHAND-Kids one of the most widely used tools for assessing manual ability in children with CP.

Rehabilitation specialists in Ukraine show growing interest towards widespread and reliable diagnostic measures [20]. To be used in other languages, however, self-reported measures have to be cross-culturally adapted and validated first. Cross-cultural adaptation involves translating the questionnaire as close as possible to the original version as possible. A linguistic adaptation is required but it is not sufficient to cross-culturally validate a scale [21]. The actual proof of a valid translation is only obtained by verifying the equivalence of the items’ difficulty across languages, a step that is possible with the Rasch methodology. In theory, ABILHAND-Kids items should be of identical difficulty for all nationalities or cultures, regardless of the language version being used. On practice, however, item difficulty hierarchy (i.e., the calibrations of the items) can vary across cultures. This may be due to cultural differences (e.g., the item “eating” of the Functional Independence Measure was systematically more difficult for the Chinese who eat with chopsticks than the Americans who eat with forks and knives). So, even if the linguistic translation of ABILHAND-Kids into Ukrainian is perfect, the item difficulties might change due to cultural differences, leading to different item calibrations of the questionnaire. ABILHAND-Kids has already been successfully adapted into multiple languages: besides the original French version, there are several other versions [22].

In this study, we aimed to: (1) design a Ukrainian version of the ABILHAND-Kids questionnaire, (2) test its psychometric properties in a sample of Ukrainian children with cerebral palsy, (3) cross-culturally validate the adapted Ukrainian version of the questionnaire.

Methods

Participants

To match the original Belgian sample size of 113 children, we recruited a corresponding number of participants among the patients of the International Clinic of Rehabilitation (Truskavets, Ukraine). All participants were informed about the study prior to the completion of the questionnaire and the parents gave their written informed consent. Eligibility criteria included: (1) diagnosis of CP; (2) age from 6 to 16 years, (3) compliant parents.

Parents whose children met the eligibility criteria filled in the Ukrainian version of the questionnaire. All patients’ data were collected in the International Clinic of Rehabilitation between November 2017 and May 2018. Information concerning child’s age, gender, clinical form of CP, MACS [23] and Gross Motor Function Classification System (GMFCS) [24] levels were obtained from the patients’ medical history. After evaluation of the submitted documents, including study design and the sample of the questionnaire, local Ethics Committee of the International Clinic of Rehabilitation approved the study (Protocol Number N- 2017–10–18).

Instrument

ABILHAND-Kids is a questionnaire that assesses manual ability of children with CP from a caregiver’s perspective. It consists of 21 mainly bimanual items that are representative of a daily routine of most children. Three of the items are usually performed with one hand, and 18 are bimanual. Bimanual activities are of three types: the first includes typically bimanual activities that can be broken down into several smaller unimanual steps (n = 12); the second includes activities where one hand stabilizes the object, and another manipulates it (n = 4), the third includes activities requiring fine digital manipulation of both hands (n = 2). For each item, the parents are asked to provide their perceived child’s difficulty on a three-level scale: Impossible (score of 0), Difficult (score of 1), or Easy (score of 2) [3]. They are also instructed to tick a question mark (encoded as a missing response) if they cannot estimate the difficulty of the activity for their child because he/she has not performed the item in the last 3 months [16].

Design

The study comprised three phases: (1) cross-cultural adaptation of ABILHAND-Kids into Ukrainian; (2) analysis of the psychometric properties of the Ukrainian version; (3) cross-cultural validation. Authors of the ABILHAND-Kids have given their permission to implement these phases of cross-cultural adaptation and validation of the questionnaire.

Cross-cultural adaptation

Cross-cultural adaptation is the process of achieving equivalence between the original source and target version of the questionnaire that is to be used in a new cultural environment and/or language [21,25]. The linguistic adaptation was performed in accordance with the guidelines published by Beaton et al and comprised five stages: translation, synthesis, back translation, experts’ committee review, and pretesting [21].

Firstly, two bilingual researchers, native speakers of Ukrainian, independently translated the questionnaire from English to Ukrainian. One of the translators was familiar with ABILHAND-Kids questionnaire, while the other was not. Each reported the difficulties encountered during translation. Secondly, the researchers discussed their translations with each other to identify and resolve discrepancies between their versions and to form a sole version of the questionnaire, namely a synthesis. Thirdly, two other bilingual translators, independently translated back the Ukrainian version into English. The two back-translators had no medical background and were unfamiliar with the ABILHAND-Kids questionnaire. Back translations were then compared with the original English version of the questionnaire to find any major discrepancies, which might have arisen during the translation process. The fourth stage included all involved translators, health care professionals, and a linguist. The experts’ committee reviewed the backward translations to verify semantic (i.e., sentence structure, colloquialisms, and idioms from the original version are translated without losing the item meaning), content (i.e., items are equally prevalent in both cultures ~ 80%) and conceptual equivalence (i.e., items of the questionnaire exist in both languages) of the Ukrainian version of the ABILHAND-Kids questionnaire to the original one [25]. After the discussion, the experts’ committee approved the pre-final Ukrainian version. The fifth stage consisted in submitting this pre-final Ukrainian version to a sample of 34 child’s parents. The participants of the pretest completed the questionnaire and were interviewed for any confusing items or
any part of the questionnaire which were difficult to understand. All comments were discussed before the approval of the final Ukrainian adaptation. Obtained data of 34 parents were not used for the final calibration of the Ukrainian version.

Analysis of psychometric properties

Rasch model

Analysis of psychometric properties (referring to the reliability and validity of an instrument) of the Ukrainian ABILHAND-Kids was done by verifying whether the scale met the requirements of an objective measurement. For this purpose, we applied the Rasch model through the RUMM2020 computer program (RUMM Laboratory Pty, Ltd, Perth, Western Australia) [26]. The probabilistic Rasch model, increasingly used in the development of measurement tools in the health care, estimates the capacity of each person and the difficulty of each item on a common linear scale from the answer of every person to every item [15]. It also converts the observed ordinal total scores into linear measures expressed in logits – measurement units that are constant and reproducible throughout the measurement scale. At any level of the measurement scale, a 1-logit difference in subjects’ ability implies a constant ratio of their odds of success ($e^{1.271}$) to any given item. To provide a more common and understandable measurement unit, the logit unit has been transformed into a centile scale where 0% represents the lowest manual ability level and 100% – the highest. The rating scale model was chosen, as done during the development of the original ABILHAND-Kids scale [16]. The rating scale model forces all items to have the same response structure. In other words, the relative locations of the thresholds do not vary from one item to the other and the range of measurement for which the intermediate response category (i.e., “difficult”) is the most likely is always the same.

The criteria used to verify the psychometric properties of the Ukrainian ABILHAND-Kids were:

1. Relevant items: an item is considered relevant when it belongs to the daily reality of most children. Items with a response rate $\geq 80$% were considered as relevant [27-30].

2. Unidimensionality: unidimensionality implies that no attribute of a person besides manual ability is theorized to account for the probability of choosing a given response to a given item. Items presenting standardized residual values between $-2.5$ and $2.5$ or a $p$-value of the $\chi^2$ fit statistic (computed over 4 class intervals of increasing ability levels) $\geq 0.05$ were considered as unidimensional [10]. Due to the number of statistical tests undertaken, Bonferroni corrections were applied to $p$-values of fit statistics (i.e., $p = 0.05/\text{number of items} = 0.0024$) [31]. The Principal component analysis was also performed on the residuals (i.e., the differences between observed and expected scores) to identify the factor that best explains observed responses variations not attributable to manual ability. The scale is considered as unidimensional if the first residual factor accounts for less than 30% of the observed variance [32]. Independent $t$-tests were also used to compare the estimates for each subject, deriving from the highest positive and negative loadings items (correlated at $\geq 0.3$ with the first residual factor) [33]. The scale is considered as unidimensional when the percentage of tests outside the range $\pm 1.96$ is less than 5%.

3. No differential item functioning: children with identical manual ability but different demographic or clinical characteristics should have the same probability of succeeding any particular item. If this is not the case, the item presents “differential functioning”. The invariance of the item difficulty hierarchy was tested for age ($\leq 10$ years old vs. $> 10$ years old), gender, clinical type of CP (hemiplegia vs. diplegia vs. quadriplegia), MACS level (MACS $= I-II$ vs. MACS $\geq I-III$) [24], and GMFCS level (GMFCS $= I-II$ vs. GMFCS $\geq III$) [23]. DIF was measured by computing a two-way analysis of variance on the standardized residuals of 4 class intervals of increasing ability levels; the first factor was the investigated child’s characteristics (age, gender, clinical form of CP, MACS and GMFCS levels) and the second factor was the class interval [34]. Items presenting a significant main effect for the first patient factor indicate a significant differential item functioning. Due to the number of statistical tests undertaken, Bonferroni corrections were applied to $p$-values of differential item functioning statistics (i.e., $p = 0.05/\text{number of items} = 0.0024$) [13]. One solution to the presence of differential item functioning is to remove items showing difficulty variations. Another option is to allow for the variations that exist across differential item functioning items by splitting them into specific items, one for each subgroup of the problematic characteristic, with a difficulty peculiar to each subgroup [35].

4. Local independency: local dependency occurs when the scores attributed to the subjects to an item depend on the scores given to another item of the same scale [36]. Residual correlations between two items higher than 0.3 indicate local dependency. However, local dependency is not a threat to the psychometric properties of the scale if the absolute value of the average residual correlations is lower than 0.2 [37].

Item-patient targeting and internal consistency reliability

Item-patient targeting was verified by comparing mean children’s measures and mean item difficulty (arbitrary set at 0 logit or 50% of logits) to verify whether the difficulty of the scale was globally well adapted to the sample. Item-patient targeting was also visually analyzed by comparing children’s measures and item thresholds (i.e., the graduations or locations along the scale at which two successive response categories are equally likely to be observed) distributions to detect potential gaps in the scale. Gaps would prevent the distinction between several children with different manual ability levels located in this area. Percentage of children with minimum (0% of logits) or maximum total score (100% of logits) $\geq 15$% was considered as a significant floor and ceiling effect [38].

The degree of precision achieved by the Ukrainian ABILHAND-Kids (i.e., internal consistency reliability) was examined by computing the Rasch person separation index (range: 0–1). The person separation index values $\geq 0.9$ indicate high internal consistency. The person separation index allows the number of manual ability levels that may be statistically distinguished in the sample to be calculated [39].

Cross-cultural validation

Cross-cultural validation refers to whether the measures originally generated by a questionnaire in a single culture are applicable, meaningful, and thus equivalent in another culture [40]. Similar to the graduations of a metric ruler, ABILHAND-Kids items should have the same difficulty for all nationalities or cultures, regardless of the language version being used. A linguistic validation is not sufficient to prove cross-cultural validity as item difficulties may vary across countries due to translation errors or cultural differences. Cross-cultural validity is only obtained by verifying the absence of differential item functioning between cultural groups.
To investigate the differential item functioning across countries (Ukraine vs. Belgium), Ukrainian data were pooled with the original data of 113 Belgian children with CP [3]. Differential item functioning across countries was measured by computing a two-way analysis of variance on the standardized residuals of 4 class intervals of increasing ability levels; the first factor was the child’s country (Ukraine vs. Belgium) and the second factor was the class interval. Items presenting a significant main effect for the first factor indicate a significant differential item functioning or, in other words, that their difficulty varies across countries. Due to the number of statistical tests undertaken, Bonferroni corrections were applied to p values of differential item functioning statistics (i.e., p = 0.05/number of items = 0.0024) [13].

Results

Sample characteristics

Hundred and thirteen children with CP (68 boys; 45 girls) with a mean age of 10.3 ± 2.9 years (range = 6–16 years) participated in this study. Most of the children (71%) presented quadriplegia with various MACS and GMFCS levels. Only the most severe level of MACS and GMFCS was not well represented in our sample. Table 1 shows the demographic and clinical characteristics of the sample of Ukrainian children with CP.

Psychometric properties of Ukrainian ABILHAND-Kids

Relevant items

All items have less than 20% of missing values in our sample, indicating that the 21 items were relevant for the Ukrainian subjects. “Opening a jar of jam” was the least answered item with a missing rate of 12%.

Unidimensionality

One major misfit was found for “Rolling up a sleeve of a sweater” as indicated by its too high standardized residuals (4.61). This item was removed as it threatened the unidimensionality of the questionnaire. According to the Bonferroni adjustment, no other major misfit was found in the remaining items as indicated by the goodness-of-fit statistic tests (all standardized residual values contained between −2.5 and 2.5; all ¸2 p values > 0.0024; Table 2). The principal component analysis on the residuals showed that the first residual factor (not attributable to manual ability) accounts for only 10% of the observed variance. Moreover, the percentage of individual t-tests outside the range ± 1.96 (95% confidence interval) was 4.90%, showing that the responses variations not attributable to the children’s manual ability were not sufficient to threaten the unidimensionality of the scale, once “Rolling up a sleeve of a sweater” was removed.

Differential item functioning

According to the Bonferroni adjustment, no major differential item functioning was present for age, clinical type of CP, MACS and GMFCS levels indicating that the scale is used in the same way for age and clinical subgroups of children with CP as the item difficulty hierarchy is invariant. However, the difficulty of “Putting on a backpack/schoolbag” varied according to gender (p values of the main first factor patient effect = 0.0008). Indeed, this item was systematically easier for Ukrainian girls and more difficult for Ukrainian boys. Consequently, the item was split into gender-specific items, one for girls (item difficulty: 57.70% of logits) and the other for boys (item difficulty: 70.61% of logits). The difficulty of all other items was invariant across gender (p values of the main first patient factor effect > 0.0024).

Local independency

There was no important local dependency (R > 0.70) between pairs of items. However, two small and one moderate local dependencies were present between (1) “Taking a coin out of a pocket” and “Washing the upper body” (R = 0.32), (2) “Buttoning up a shirt” and “Buttoning up trousers” (R = 0.34), and (3) “Putting on a backpack/schoolbag girl” (gender-specific item) and “Opening a jar of jam” (R = 0.56). However, the absolute value of the average residual correlations was lower than 0.2 (absolute value of −0.049) indicating that the observed small and moderate local dependencies are not a threat for the psychometric properties of the scale.

Calibration of Ukrainian ABILHAND-Kids

The calibration of the 20-item Ukrainian ABILHAND-Kids scale (19 items + 1 item split according to gender) is presented in Table 2. The items are sorted, from top to bottom, in order of increasing difficulty (range: −2.82 to 2.33 logits). Higher logit values indicate more difficult activities. Table 2 also reports the difficulty of the
Table 2. Ukrainian ABILHAND-Kids calibration for children with cerebral palsy.

<table>
<thead>
<tr>
<th>Items</th>
<th>Difficulty (logits)</th>
<th>Difficulty (% of logits)</th>
<th>SE (logits)</th>
<th>SE (% of logits)</th>
<th>Standardized residuals</th>
<th>Chi-square ($\chi^2$)</th>
<th>Probability of the $\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switching on a bedside lamp</td>
<td>−2.82</td>
<td>24.29</td>
<td>0.37</td>
<td>3.42</td>
<td>−0.78</td>
<td>1.48</td>
<td>0.69</td>
</tr>
<tr>
<td>Opening a breadbox</td>
<td>−2.73</td>
<td>25.19</td>
<td>0.37</td>
<td>3.42</td>
<td>−0.76</td>
<td>0.95</td>
<td>0.81</td>
</tr>
<tr>
<td>Unwrapping a chocolate bar</td>
<td>−2.14</td>
<td>30.68</td>
<td>0.30</td>
<td>2.81</td>
<td>0.97</td>
<td>4.79</td>
<td>0.19</td>
</tr>
<tr>
<td>Taking a coin out of a pocket</td>
<td>−1.24</td>
<td>39.07</td>
<td>0.25</td>
<td>2.33</td>
<td>1.25</td>
<td>7.38</td>
<td>0.06</td>
</tr>
<tr>
<td>Opening the cap of a toothpaste tube</td>
<td>−1.12</td>
<td>40.23</td>
<td>0.25</td>
<td>2.29</td>
<td>0.39</td>
<td>2.08</td>
<td>0.56</td>
</tr>
<tr>
<td>Putting on a hat</td>
<td>−1.04</td>
<td>40.94</td>
<td>0.23</td>
<td>2.19</td>
<td>−1.72</td>
<td>4.45</td>
<td>0.22</td>
</tr>
<tr>
<td>Squeezing toothpaste onto a toothbrush</td>
<td>−0.70</td>
<td>44.08</td>
<td>0.23</td>
<td>2.16</td>
<td>1.07</td>
<td>6.56</td>
<td>0.09</td>
</tr>
<tr>
<td>Unscrewing a bottle cap</td>
<td>−0.65</td>
<td>44.63</td>
<td>0.22</td>
<td>2.04</td>
<td>1.58</td>
<td>12.09</td>
<td>0.01</td>
</tr>
<tr>
<td>Filling a glass with water</td>
<td>−0.36</td>
<td>47.29</td>
<td>0.21</td>
<td>1.95</td>
<td>−0.03</td>
<td>1.97</td>
<td>0.58</td>
</tr>
<tr>
<td>Washing the upper body</td>
<td>−0.21</td>
<td>48.69</td>
<td>0.21</td>
<td>1.96</td>
<td>−0.04</td>
<td>8.86</td>
<td>0.03</td>
</tr>
<tr>
<td>Opening a bag of chips</td>
<td>−0.12</td>
<td>49.55</td>
<td>0.21</td>
<td>1.96</td>
<td>−0.26</td>
<td>5.03</td>
<td>0.17</td>
</tr>
<tr>
<td>Taking off a T-shirt</td>
<td>0.08</td>
<td>51.36</td>
<td>0.20</td>
<td>1.82</td>
<td>0.17</td>
<td>3.73</td>
<td>0.29</td>
</tr>
<tr>
<td>Fastening the snap of a jacket</td>
<td>0.69</td>
<td>57.06</td>
<td>0.19</td>
<td>1.73</td>
<td>−0.89</td>
<td>7.83</td>
<td>0.05</td>
</tr>
<tr>
<td>Zipping up a jacket</td>
<td>0.72</td>
<td>57.40</td>
<td>0.18</td>
<td>1.70</td>
<td>−2.19</td>
<td>5.49</td>
<td>0.14</td>
</tr>
<tr>
<td>Putting on a backpack/schoolbag_girl</td>
<td>0.75</td>
<td>57.70</td>
<td>0.29</td>
<td>2.70</td>
<td>0.26</td>
<td>2.73</td>
<td>0.44</td>
</tr>
<tr>
<td>Sharpening a pencil</td>
<td>1.02</td>
<td>60.16</td>
<td>0.19</td>
<td>1.75</td>
<td>0.11</td>
<td>4.68</td>
<td>0.20</td>
</tr>
<tr>
<td>Zipping up trousers</td>
<td>1.10</td>
<td>60.90</td>
<td>0.18</td>
<td>1.69</td>
<td>−0.90</td>
<td>6.31</td>
<td>0.10</td>
</tr>
<tr>
<td>Buttoning up a shirt/sweater</td>
<td>2.13</td>
<td>70.53</td>
<td>0.18</td>
<td>1.67</td>
<td>−1.34</td>
<td>0.86</td>
<td>0.83</td>
</tr>
<tr>
<td>Putting on a backpack/schoolbag_boy</td>
<td>2.14</td>
<td>70.61</td>
<td>0.24</td>
<td>2.21</td>
<td>−0.52</td>
<td>1.89</td>
<td>0.60</td>
</tr>
<tr>
<td>Opening a jar of jam</td>
<td>2.17</td>
<td>70.93</td>
<td>0.19</td>
<td>1.79</td>
<td>1.50</td>
<td>6.05</td>
<td>0.11</td>
</tr>
<tr>
<td>Buttoning up trousers</td>
<td>2.33</td>
<td>72.42</td>
<td>0.18</td>
<td>1.68</td>
<td>−1.07</td>
<td>2.69</td>
<td>0.44</td>
</tr>
</tbody>
</table>

SE: standard error.

**Description of Ukrainian ABILHAND-Kids**

The definition and use of the Ukrainian ABILHAND-Kids scale are depicted in Figure 1. The top panel shows the distribution of manual ability measures of the children as perceived by the parents while the upper middle panel shows the distribution of the 42 Ukrainian ABILHAND-Kids items’ thresholds. The bottom panel illustrates the sigmoidal (S-shaped) curve relationship between the finite total raw scores and the infinite manual ability measures (expressed in % and in logits). This relationship is approximately linear between total scores of 12 and 30. Outside of this central range, a unitary progression in total score accounts for an increasing amount of manual ability measure. In the central range, the change in manual ability measure corresponding to a unitary increment in the total score from 21 to 22 is equal to 1.31% (0.14 logits).

Outside of this central range, it increases to 8.22% (0.88 logits) for the same increment in the total score from 0 to 1. This sixfold difference denotes the non-linearity of the total score. The conversion between raw total scores and linear measures of the Ukrainian ABILHAND-Kids is given in Supplementary File. Note that the conversion table is only useful without missing data. The lower middle panel shows the expected response to a given item as a function of the underlying manual ability measure. For all items, the distance between the two thresholds was 16.93% (1.81 logits) as the rating scale model was used. By comparing the ability of a given child to the difficulty of each item, it is possible to determine the expected score of the child to the item. According to the parents’ perception, a child with a total raw score of 21 will have an ability close to 50% (0 logit) and would be expected to perform the six easiest activities without difficulty and average activities with some difficulties; the six most difficult activities would be impossible to perform.

**Item-patient targeting and internal consistency reliability**

The mean item difficulty was equal to 50 ± 14.49% (0 ± 1.55 logits) and the mean children’s manual ability measure was equal to 63 ± 21.78% (1.33 ± 2.33 logits) meaning that the difficulty of the scale was relatively well adapted to our sample but slightly too easy. Top and upper middle panels of Figure 1 show the item-patient targeting. No major gaps were present on the Ukrainian ABILHAND-Kids manual ability measurement scale from 31 to 69% (from −2.15 to 2.00 logits). However, some gaps appear between 17 and 22% (−3.63 and −3.04 logits), between 22 and 31% (−3.04 and −2.15 logits), between 69 and 79% (2.00 and 3.03 logits), and beyond 81% (3.24 logits). The questionnaire will be unable to differentiate children with slightly different manual ability levels located in a given gap.

According to the distribution of subject measures, 52% of the children in our sample should be able to successfully perform all the listed activities easily or with some difficulty. Nineteen percent of the children should be able to perform all activities easily and 4% should not be able to perform any of the 20 Ukrainian ABILHAND-Kids items (Figure 1). Only five parents of Ukrainian children with CP (4%) reported a minimum total score (0% of logits) and six parents (5%) reported a maximal total score (100% of logits) on the questionnaire. The manual ability of their children cannot be measured by the Ukrainian ABILHAND-Kids scale because all activities are either impossible or easy. However, no significant floor and ceiling effects were observed on the Ukrainian ABILHAND-Kids (percentage of children with extreme scores < 15%).

The person separation index was equal to 0.95 indicating that the scale has good precision, enabling between 6 and 7 manual ability levels to be statistically distinguished in our sample.

**Cross-cultural validity**

The invariance of the item difficulties was investigated across countries (Ukraine vs. Belgium) by pooling Ukrainian data with the data of 113 Belgian children with CP. Items including gender, age, handedness, type of education, type of cerebral palsy (tetra-, di-, or hemiplegia), affected side, and overall ability were considered as invariant [16]. Three major differential item functioning...
items were observed across countries: “Taking off a T-shirt” \( (p = 0.0003) \) which was easier for Belgians, “Opening a bread box” \( (p < 0.0001) \) which was easier for Ukrainians, and the boy-specific item “Putting on a backpack/schoolbag_boy” which was easier for Belgians. The Figure 2 shows the item characteristic curves (solid lines representing the score expected by the Rasch model according to the manual ability) and mean observed scores (dots) for 4 interval class of CP children for Belgium (gray circles) and Ukraine (white triangles).

Panel A illustrates one item (“Unwrapping a chocolate bar”) presenting no differential item functioning. The mean scores observed for the children (in the 4 increasing ability levels) of the two countries present similar patterns that superimpose, meaning that the difficulty of these items does not vary according to the children’s culture. Panels B, C, and D illustrate the three items (“Taking off a T-shirt”, “Opening a bread box”, and “Putting on a backpack/schoolbag_boy”, respectively) presenting a major differential item functioning across countries. The mean scores observed for children of both countries evolve in parallel. For a given manual ability level, the score observed on “Taking off a T-shirt” (panel B) and “Putting on a backpack/schoolbag_boy” (panel D) is systematically higher for Belgians and systematically lower for Ukrainians. In other words, these items are systematically easier for Belgians and more difficult for Ukrainians. It is the
opposite for “Opening a bread box” (panel C). These results indicate that the difficulty of these three items differs from one country to the other, highlighting the importance to use Ukrainian calibration in Ukraine.

Discussion

We designed a Ukrainian version of ABILHAND-Kids, which showed good psychometric qualities for assessing manual ability in Ukrainian children with cerebral palsy. Only three of the 20 items in the questionnaire showed differential item functioning across countries, meaning that most items are of comparable difficulty for Belgians and Ukrainians, but also that Ukrainian calibration is required to use ABILHAND-Kids in Ukraine.

The adapted version of the questionnaire seems to be relevant to the daily routine of most Ukrainian children as all items were answered by at least 88% of the respondents. “Opening a jar of jam” was the less relevant item probably due to cultural peculiarities. The item refers to jar with screw caps which is typically used in commercial jars of jam but which is not the most frequent type of caps used to seal a jar of jam in Ukraine. Indeed, in Ukraine, many families prepare homemade jam, which is usually sealed with plastic lids. This can explain the lower response rate of the item “Opening a jar of jam”.

Only one item – “Rolling up a sleeve of a sweater” – was a threat for the unidimensionality of the Ukrainian version of ABILHAND-Kids and had to be removed. The misfit was likely due to the misinterpretation of the item by some parents: rolling up the sleeve might have been misconstrued as creasing the sleeve or turning it upside down. Once the item was removed, no other major misfit was found meaning that all 20 remaining items contributed to the definition of a unidimensional measure of manual ability. Moreover, the responses variations not attributable to the children’s manual ability were insufficient to compromise the unidimensionality of the questionnaire, once “Rolling up a sleeve of a sweater” was removed.

Differential Item Functioning analyses showed that the 20-item Ukrainian version of ABILHAND-Kids was invariant across age, clinical type of CP, MACS and GMFCS levels meaning that the scale can be used whatever the age and the clinical subgroups of Ukrainian children with CP. Only “Putting on a backpack/schoolbag” showed a differential item functioning across gender as its difficulty was systematically lower for Ukrainian girls and systematically higher for Ukrainian boys. A plausible explanation to this could be that in Ukraine many girls of middle and high school age use handbags rather than backpacks; using handbags being easier than using backpacks as it is carried on one shoulder. However, there may be another unknown factor responsible for the variance of this item across gender as it was also systematically more difficult for Ukrainian boys than Belgian children (for whom no gender-invariance was found) while it was not the case for girls [41]. Considering the differential item functioning observed across gender for “Putting on a backpack/schoolbag” and the possibility that different skills may be measured in Ukrainian boys and girls, the item was split into two gender-

Figure 2. Cross-cultural validity of ABILHAND-Kids through Differential Item Functioning analysis across the Ukraine and Belgium. Item characteristic curves (solid lines representing the score expected by the Rasch model according to the manual ability level) and mean observed scores (dots) for 4 interval classes of subjects (Belgian children represented by gray circles and Ukrainian children by white triangles) with increasing manual ability levels allowing to investigate differential item functioning (DIF) across countries. Panel A: item characteristic curve of the item “Unwrapping a chocolate bar” which present no DIF across countries. Panels B, C and D: item characteristic curves of items “Taking off a T-shirt” (panel B), “Opening breadbox” (panel C), and “Putting on a backpack/schoolbag_boy” (panel D) which present a DIF across countries.
specific items (one for girls and the other for boys). However, as parents will actually respond to only one of these two gender-specific items, depending on the gender of their child, we can consider that 20 items constitute the final Ukrainian version of ABILHAND-Kids.

No important local dependency was found between pairs of items. However, the few minor and moderate local dependencies observed were quite interesting. Dependency between “Taking a coin out of a pocket” and “Washing the upper body” may arise because these are two items performed with one hand. “Buttoning up a shirt” and “Buttoning up trousers” both require the same kind of movements to be completed. The local dependency between “Putting on a backpack/schoolbag girl” (girl-specific item) and “Opening a jar of jam” is more obscure. However, the few local dependencies do not affect the psychometric qualities of the scale as shown by the insignificant average residual correlations. This is consistent with the absence of local dependency observed in the Turkish and Persian versions of ABILHAND-Kids [42,43].

The 20 items of the Ukrainian ABILHAND-Kids provide a unidimensional measure of manual ability expressed on an interval-level scale (in logits or % of logits) enabling the manual ability changes of Ukrainian children with CP to be monitored over time. Such as the original ABILHAND-Kids scale, the item difficulty hierarchy of the Ukrainian version is congruent with clinical observations strengthening the validity of the scale [16]. For each child assessed, the hierarchical nature of the scale provides clinicians with information on which tasks have already been mastered and which are likely to be mastered in the future. The total raw scores have been transformed into Rasch interval-level measures (in logits) which were subsequently rescaled into a centile scale (0% representing the lowest ability and 100% the highest one) to be more user-friendly and clinically meaningful. A conversion table between raw scores and recommended centile measures was provided (in Supplementary File) and can be used by clinicians to compare the manual ability of various children or follow-up over when all ABILHAND-Kids items are scored.

Moreover, Ukrainian ABILHAND-Kids presents a high degree of precision since, despite some gaps, the 20 items are relatively well targeted on our sample (person separation index: 0.94). The scale has the potential to statistically distinguish between 6 and 7 different manual ability levels in our sample. Similar results were found for the original Belgian (person separation index: 0.94), Persian (person separation index: 0.96), and Brazilian-Portuguese (Cronbach’s Alpha: 0.99) ABILHAND-Kids versions [16,43,44]. Only the Turkish version of ABILHAND-Kids showed lower precision (Cronbach’s alpha = 0.81) [42]. Consistently with other versions of ABILHAND-Kids, no significant floor and ceiling effects were observed in the Ukrainian ABILHAND-Kids [16,42]. The high precision of the Ukrainian ABILHAND-Kids scale and its lack of floor and ceiling effects indicate the potential of the scale to detect sensible change in manual ability in children with CP. According to their parents, only 4% of the children with CP were unable to perform at least one item and 5% of them were able to perform all items easily. All five children with minimal score had spastic tetraplegia, GMFCS levels between III and V and MACS levels IV–V. The six children with maximal score were mostly diplegic or hemiplegic, with GMFCS and MACS levels I or II.

This study investigates the cross-cultural validity of ABILHAND-Kids through Rasch analysis, likewise in the sample of Persian participants [43]. Rasch analysis was not performed for the Brazilian Portuguese ABILHAND-Kids, and cross-cultural analysis was not reported for the Turkish ABILHAND-Kids [42,44]. In our study, three major differential item functioning items (“Taking off a T-shirt”, “Opening a bread box”, and “Putting on a backpack/schoolbag boy”) were observed across countries indicating that the difficulty of these three items changes from one country to the other. These three items with differential item functioning across Belgian and Ukrainian children are an obstacle to using the original ABILHAND-Kids in Ukraine. “Taking off a T-shirt” and “Putting on a backpack/schoolbag boy” (boy-specific item) was easier for Belgians while “Opening a bread box” was easier for Ukrainians. These differential item functioning items might be explained by cultural differences between the two countries or might be attributable to different clinical characteristics between Belgian and Ukrainian samples. As an example of the cultural differences, Ukrainians annually consume, on average, 89 kilogram of bread per person (being one of the 3 top European countries by bread consumption), while Belgians consume, on average, 55 kilogram/person/year [45]. Ukrainian kids, therefore, use bread box more often than their Belgian peers, which might have contributed to the differential item functioning.

As for differences in clinical characteristics, most children in the Belgian study had hemiplegia while in ours they were predominantly quadriplegic. The differential item functioning in items “Taking off a T-shirt” and “Putting on a backpack/schoolbag boy” might have occurred because of the parents helping the quadriplegic children. Similar discrepancies were found in the Persian sample with the items “Unwrapping chocolate bar” (systematically easier for Belgians) and “Opening bread box” (systematically easier for Iranians) [43]. The differential functioning observed across countries and the adaptation of the original scale (removing of one item, splitting of one item across gender) highlight the need to use the local calibration of ABILHAND-Kids rather than the original one.

A potential limitation of this study is that the questionnaire was completed by the children’s parents. The parents’ subjective perception of their child’s ability may sometimes be prone to an over- or under-estimation of the child’s actual performance [15]. On the other hand, parents’ reports may be more valuable than experts’ observations as parents observe their child’s manual ability on a regular basis, capturing a sort of weighted average of the performance over long periods of time [16]. A recent study has compared parents-reported measures of their child’s manual ability to examiners’ home-observed-measures [19]. The authors showed that parents and examiners have a similar perception of the child’s performance during conventional therapy.

Despite this limitation, the Ukrainian version of ABILHAND-Kids seems to be a valid, robust, and precise local tool for assessing manual ability in Ukrainian children with CP. Due to its practicality and ease to administer – requiring no special training and taking only up to 5 min to be completed – the tool has a great potential to be implemented in clinical practice nationwide. ABILHAND-Kids also promises significant benefits to cerebral palsy research in Ukraine, providing Ukrainian researchers with a robust and accessible tool to study hand function. In a global context, this study is a successful example of adapting a well-established international tool to local culture. However, further research is required to investigate test-retest and rater reliability of the Ukrainian version of ABILHAND-Kids, to study its responsiveness-to-change, and to determine its smallest detectable difference to indicate what is a “true change”. We expect that our experience with the Ukrainian ABILHAND-Kids could encourage foreign colleagues to adopt the best international practices to cross-culturally validate gold-standard tools before using them in a given cultural context.
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No potential conflict of interest was reported by the authors.

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