Cerebral palsy (CP) describes a group of disorders of movement and posture that are attributed to a non-progressive disorder in the immature brain and often limit functional activities1. Children with spastic hemiplegia, which is one type of CP, can experience difficulty in using the affected upper limb (AUL) – the limb contralateral to the lesion – because of poor selective motor control, muscle weakness, a stereotyped posture, and sensory deficits. These difficulties make attempts to use the AUL less frequent, and favor compensatory strategies in which the unaffected limb is used to perform functional activities. This can culminate in a cycle that results in decreased cortical representation of the affected segment because of disuse, thus developing the phenomenon known as “learned nonuse”2.

Traditionally, the functionality of the AUL has been evaluated by observing motor performance during tests conducted in the clinic. However, the use of the AUL in this context often fails to reflect how the child actually performs in the real world3,4. The relationship between performance assessed by tests in the clinic environment and the spontaneous use of the AUL outside the therapeutic setting has not been established. Clinic-based tests do not take into consideration the phenomenon of learned nonuse, and therefore the effects of rehabilitation on everyday function are not properly evaluated3,4.

A standardized instrument developed specifically to evaluate the function and spontaneous use of the AUL in children aged 2–8 years with CP is the Pediatric Motor Activity Log Revised (PMAL-R). The standardized instrument developed to assess the use of the affected upper limb in children with cerebral palsy (CP) is the Pediatric Motor Activity Log Revised (PMAL-R). Objectives: To translate PMAL-R and adapt for the Brazilian culture; analyze the reliability and the internal consistency of the Brazilian version. Method: Translation of PMAL-R to the Portuguese-Brazil and back translation. The back-translated version was revised by the authors of the scale. The final version was administered to a sample of 24 patients with spastic hemiparesis CP between 2–8 years. Results: The reliability intra and inter-rater were suitable (how often = 0.97 and 0.98, how well = 0.98 and 0.99 respectively) and so the internal consistency (0.98). Conclusion: The Brazilian version of PMAL-R has adequate internal consistency, reliability intra and inter raters and can be used to assess the spontaneous use of the upper limb of children with CP type spastic hemiparesis, aged 2–8 years.

Keywords: cerebral palsy; upper extremity; activities of daily living; evaluation.

RESUMO

A Pediatric Motor Activity Log-Revised (PMAL-R) é um instrumento padronizado desenvolvido para avaliar o uso do membro superior afetado em crianças com paralisia cerebral (PC). Objetivos: Traduzir a PMAL-R e fazer sua adaptação transcultural para o Português do Brasil; analisar a confiabilidade e a consistência interna da versão brasileira. Métodos: Tradução e retrotradução da PMAL-R. A versão retrotraduzida foi revista pelos autores da escala; a versão final foi administrada a uma amostra de 24 pacientes com PC do tipo hemiparesia espástica entre 2–8 anos. Resultados: Adequada confiabilidade intra e inter-avaliadores (frequência = 0,97 e 0,98, qualidade = 0,98 e 0,99, respectivamente), assim como a consistência interna (0,98). Conclusão: A versão brasileira da PMAL-R apresenta consistência interna e confiabilidade intra e inter examinadores adequadas, sendo válida para avaliar o uso espontâneo do membro superior de crianças com PC do tipo hemiparesia espástica, com idade entre 2–8 anos.

Palavras-chave: paralisia cerebral; extremidade superior; atividades cotidianas; avaliação.
Translation of the instrument

The PMAL-R was translated into Brazilian Portuguese by two bilingual translators whose native language was Portuguese. Translations were performed independently to obtain a more appropriate translated version\(^3,10\). The researchers then analyzed the two translated versions and the original English version and participated in a comparative discussion in order to obtain a single, final version in the Portuguese language (version consensus, Version 1 [V1]).

V1 was back-translated by two further qualified translators, whose original language was English (the language of the original instrument) and who had no prior knowledge of the intent or concepts of the material. The back-translators performed this process independently. The back-translations were then subjected to a comparative analysis among the researchers regarding the two back-translated versions and the original, to obtain a single, final version in English language (version consensus, Version 2 [V2]).

V2 was sent to the original authors of the PMAL-R for correction. The authors did not change any items in this version, but made some suggestions on how to apply one item (pointing a figure – the authors recommended that it was in a book).

Semantic analysis by a judging committee

According to Pasquali, the aim of this step is to assess whether the terms used in the items are understandable, and whether they are suitable for the population under evaluation with respect to the motor activities performed by this age group\(^8\). To this end, two groups were selected: 15 judges from a low stratum (i.e., people from the field of physical rehabilitation who were unaware of the PMAL-R) and 15 from a high stratum (i.e., people in the field of pediatric physical rehabilitation with prior knowledge of the original PMAL-R\(^11\)). Items that were understood by fewer than 80% of participants (\(\frac{U}{U + NU} \times 100\)) (where U is the number of items that were understandable by the lower stratum and NU is the number of items that were not understandable) were candidates for cross-cultural adaptation. The lower stratum, in this case, represented the target population (i.e., parents or caregivers) with no knowledge of the PMAL-R\(^12\).

Although the original authors of the PMAL-R were not asked to correct V1 (i.e., PMAL-R Brazilian Portuguese) it was subjected to semantic analysis by the judging committee, who discussed the clarity of the translated items and the relevance of the instrument to the population for which it was intended (i.e., low stratum) and its clinical relevance (i.e., high stratum).
Inter- and intra-rater reliability

V1 was submitted for analysis by the committee of judges and changed based on their suggestions; the final version was called the PMAL-R Brazil. The PMAL-R was tested in a population of 24 caregivers to analyze its clinimetric properties (intra- and inter-rater reliability, and internal consistency). The sample size was selected according to Terwee and colleagues, who suggested that a sample of 4–10 subjects should be screened for each variable[^13], and taking into account that the PMAL-R has two variables (HO and HW).

Each parent or caregiver underwent two identical PMAL-R Brazil interviews conducted by two different evaluators (A and B) on the same day, with 40 minutes between each interview. After 7 days, the PMAL-R Brazil was repeated with each caregiver[^7,14,15]. Each evaluator had been trained at the University of Alabama at Birmingham (AL, USA) and followed the manual for the original PMAL-R[^7,15]. All participants signed a consent form.

Each caregiver was first given an introduction regarding the purpose of the evaluation and instructions on how to answer the questions. The evaluators then asked the caregivers about how often and how well their child used the AUL to perform the tasks listed in the PMAL-R Brazil, with reference to the previous week.

Statistical analysis

The normality of the data was tested and confirmed using the Kolmogorov–Smirnov test, and data are presented as mean ± standard deviation. Descriptive statistical analysis was used for demographic and clinical characterization of the patients. The paired Student t test was used to compare the two dependent samples. The intraclass correlation coefficient (ICC) was used to measure reliability, and is presented with a 95% confidence interval. For the ICC, reliability was characterized as good (score 0.80–1.0), moderate (0.60–0.79), or poor (< 0.60). Cronbach’s alpha was used to evaluate the internal consistency of the PMAL-R Brazil. SPSS 19.0 (Chicago, IL, USA) was used for statistical analysis[^16,17,18].

RESULTS

The demographic characteristics of the sample (N = 24) are described in Table 2.

In the semantic analysis, the committee of judges asked questions about the meaning of four of the items. Although Item 6 (“passing his arm through the sleeve of a garment”) was understood by all judges in the high stratum, it was not
understood by nine participants in the low stratum. This was mainly due to the formulation of the question, which was not specific about the length of the sleeve (Table 3). Three participants in the high stratum and nine in the low stratum were confused by Item 18 (“holding a small ball”), in particular about the size of the ball. For Item 19 (“throwing a ball or other object”), three participants of the low stratum asked about the size of the object to be thrown. For Item 20 (“using a cylindrical object–a pen, pencil, or crayon”), only one participant, in the high stratum, pointed to the word “cylindrical” as a possible generator of doubt, and suggested the use of examples that were already in the question (Table 3).

With regard to the suitability of the items for the age group being tested, only Item 14 (“Use the arm to move down – drag, crawl”) was scored as not suitable (by five participants in the high stratum). They reported that the target population (children aged 2–8 years old with hemiparesis) did not realize that this activity was intended to be ambulatory.

Both intra-rater reliability (with a mean interval of 7 days) and inter-rater reliability were excellent (ICC = 0.97–0.98 and 0.98–0.99, respectively) (Table 4). Internal consistency was also excellent (Cronbach’s alpha = 0.97 for the HO subscale and 0.98 for the HW subscale).

**DISCUSSION**

The World Health Organization recommends the translation and cross-cultural adaptation of existing instruments of evaluation, because this improves communication between researchers and permits comparison of data obtained internationally. Furthermore, the use of validated instruments increases confidence in the measurements obtained.

When adapting an instrument to a new country or culture, it is important to use a method that maintains equivalence between the original and translated versions, while at the same time making any cross-cultural adaptations required. Furthermore, the psychometric properties of the adapted instrument must be tested.

The PMAL-R assesses the functional use of the AUL in the real world, and is conducted via a structured interview using an evaluation script. This tool has demonstrated good stability, reliability, and validity.

In 2013, Rickards et al. conducted a study to identify the relationship between white-matter integrity and the corticospinal path in AUL function before and after constraint-induced movement therapy (CIMT) in children with CP with spastic hemiparesis. The authors observed a significant association between fractional anisotropy values of the corticospinal tract and pretreatment spinal motor function, with similar findings in relation to the PMAL-R. Patients with more lesions in the corticospinal path (resulting in disruption or dysplasia) showed worse results on the pretreatment PMAL-R compared with patients without lesions, indicating that the PMAL-R was sensitive enough to identify a clinical alteration that correlated with structural change.

Also in 2013, Sterling et al. conducted a piece of research that aimed to compare demonstrated gains in motor and

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**Table 2.** Demographic characteristics of patients evaluated for reliability study (mean ± standard deviation).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Patients (n = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>5.0 ± 1.7</td>
</tr>
<tr>
<td>Age (months)</td>
<td>66.2 ± 20.6</td>
</tr>
<tr>
<td>Gender n (%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>10 (41.7)</td>
</tr>
<tr>
<td>Female</td>
<td>14 (58.3)</td>
</tr>
<tr>
<td>Topographic diagnosis</td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>14 (58.3)</td>
</tr>
<tr>
<td>Right</td>
<td>10 (41.7)</td>
</tr>
<tr>
<td>Motor degrees n (%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>12 (50)</td>
</tr>
<tr>
<td>3</td>
<td>12 (50)</td>
</tr>
</tbody>
</table>

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**Table 3.** Terminology questions, percentage of non-understandable items and suggestions.

<table>
<thead>
<tr>
<th>Questioned terminology (understandable / not understandable)</th>
<th>Percentage of not understandable (NU%)</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Put arm through sleeve of garment</td>
<td>High stratum: 0 (0) Low stratum: 9 (60)</td>
<td>Wear a shirt, put the arm inside the shirt sleeve, dressing the arm through the sleeve of a shirt.</td>
</tr>
<tr>
<td>18. Hold a small ball</td>
<td>High stratum: 3 (20) Low stratum: 9 (60)</td>
<td>Holding a small ball with one hand, holding a ping-pong ball (or the same size).</td>
</tr>
<tr>
<td>19. Throwing a ball or a small object</td>
<td>High stratum: 0 (0) Low stratum: 3 (20)</td>
<td>Size of the ball, give an example.</td>
</tr>
<tr>
<td>20. Use a cylindrical object (e.g., highlighter, crayons)</td>
<td>High stratum: 1 (7) Low stratum: 0 (0)</td>
<td>Cylindrical word, should give an example.</td>
</tr>
</tbody>
</table>
functional evaluations with changes in brain gray matter using functional magnetic resonance imaging. The study showed that brain structural changes were largely accompanied by changes in the spontaneous use of the AUL in real life, as measured with the PMAL-R²⁰.

In the current study, the PMAL-R underwent the translation steps described above. In addition, an analysis of the linguistic and conceptual equivalence (semantic analysis) of the items was conducted. The conceptual equivalence is analyzed considering the translated term is relevant according to the culture in which the instrument is applied (appropriate or not appropriate). Linguistic equivalence (semantics) involves verifying whether the questions have kept the same meaning in the translation as in the original language, as well as ensuring that the words and terminology are clear, and that the sentences can be easily understood¹¹,¹⁴.

The semantic analysis tested the language from the point of view of two different groups (i.e., high and low strata). The high stratum included rehabilitation professionals with experience in pediatric neurology and who had been trained in the application of the questionnaire in its original English version. The low stratum aimed to verify whether the items would be understood by the target population (parents and/or caregivers), and was composed of rehabilitation professionals who had no experience in pediatric neurology and no previous contact with the PMAL-R.

The analysis determined that of the 22 questions in the PMAL-R Brazil, the terminology of four was questioned by the reviewers. The items selected for change were Item 6 (“passing his arm through the sleeve of a garment”) and Item 18 (“holding a small ball”), because these were understood by only 40% of the low stratum. We changed Item 6 to “put his arm through the sleeve of a T-shirt” because this reflected the motor activity desired in the item; the score was considered to be normal when the child performed a full elbow extension to wear the T-shirt.

The terminology of Item 18 was not changed. An example suggested by the lower stratum and the authors of the PMAL-R was that the size of the ball should be equal to a ping-pong ball, with this already exemplified in the question: “Holding a small ball, the size of a ping-pong ball.”

<table>
<thead>
<tr>
<th>Variable</th>
<th>ICC</th>
<th>Confidence interval (95%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra rater reliability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HO</td>
<td>0.97</td>
<td>(0.94–0.99)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>HW</td>
<td>0.98</td>
<td>(0.96–0.99)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Inter rater reliability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HO</td>
<td>0.98</td>
<td>(0.97–0.99)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>HW</td>
<td>0.997</td>
<td>(0.994–0.999)</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

ICC: intraclass correlation coefficient; p: significance level; HO: how often; HW: how well.

In conclusion, this study has demonstrated the reliability of the Brazilian version of the PMAL-R. Through our analysis of reproducibility and internal consistency, we can conclude that the PMAL-R Brazil is appropriate for the routine assessment of the AUL of patients with CP using the Gross Motor Function Classification System and found that only 1–2% of individuals in grades I and II (similar to the present study sample) crawled in the evaluation, because they already walk.²¹ Therefore, this item was discussed with the original authors of the PMAL-R and replaced with “use the arm to move on the ground – drag or crawl to grab objects underneath the furniture.”

Studies of CIMT in children aged 2–8 years have demonstrated that children can acquire new motor programs after such therapy. In younger children (around 2 years), it has been demonstrated that crawling (a motor activity that is unusual for children with hemiparesis) can be acquired after CIMT, and is incorporated into the lives of these patients both as displacement and to explore the environment.²²,²³

In the current study, there were no statistical differences in the mean scores on the two domains of the PMAL-R Brazil between two interviews conducted with the same rater on the same day, with two different examiners. The PMAL-R Brazil also demonstrated excellent internal consistency.

The function of an individual can be measured using the International Classification of Functioning, Disability and Health (ICF), which is divided into three areas: body structure, activity, and participation. The activity domain is subdivided into a capacity assessment, which shows what the individual can do, and a performance evaluation, which looks at what the individual actually does on a day-to-day basis, at home and in the community. Despite this, most assessments for children with CP are limited with respect to the evaluation of performance by being performed in a controlled environment; although ability of the child is measured, this does not reflect the performance of the child outside the therapeutic environment.²²,²⁴

The current results suggest that the PMAL-R Brazil can be included in routine AUL assessments of patients with CP. The PMAL-R Brazil is a reliable way to evaluate the performance of these individuals and thus meet the demands of the ICF.

In conclusion, this study has demonstrated the reliability of the Brazilian version of the PMAL-R. Through our analysis of reproducibility and internal consistency, we can conclude that the PMAL-R Brazil is appropriate for the routine assessment of the AUL of patients with CP with spastic hemiparesis aged 2–8 years old.
References


