"Assessing locomotion ability in West African stroke patients: Validation of ABILOCO-benin scale"

Sogbossi, Segnon Emmanuel ; Thonnard, Jean-Louis ; Batcho, Sèbiyo Charles

ABSTRACT

Objective To calibrate and validate the Benin version of ABILOCO, a Rasch-built scale developed to assess locomotion ability in stroke patients. Design Prospective study and questionnaire development. Setting Rehabilitation centers. Participants Stroke patients (N=230; mean age ± SD, 51.1±11.6y; 64.3% men). Intervention Not applicable. Main Outcome Measures Participants completed a preliminary list of 36 items including the 13 items of ABILOCO. Items were scored as "impossible," "difficult," or "easy." The mobility subdomain of FIM (FIM-mobility), the Functional Ambulation Classification (FAC), the 6-minute walk test (6MWT), and the 10-meter walk test (10MWT) were used to evaluate and elucidate the validity of the ABILOCO-Benin scale. Results Successive Rasch analyses led to the selection of 15 items that define a unidimensional, invariant, and linear measure of locomotion ability in stroke patients. This modified version of the ABILOCO scale, named ABILOCO-Benin, showed an excell...
Assessing Locomotion Ability in West African Stroke Patients: Validation of ABILOCO-Benin Scale

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Current affiliation for Batcho: Center for Interdisciplinary Research in Rehabilitation and Social Integration (CIRRIS), Université Laval, Quebec City (Quebec), Canada.

Abstract

Objective: To calibrate and validate the Benin version of ABILOCO, a Rasch-built scale developed to assess locomotion ability in stroke patients.

Design: Prospective study and questionnaire development.

Setting: Rehabilitation centers.

Participants: Stroke patients (N=230; mean age ± SD, 51.1±11.6y; 64.3% men).

Intervention: Not applicable.

Main Outcome Measures: Participants completed a preliminary list of 36 items including the 13 items of ABILOCO. Items were scored as “impossible,” “difficult,” or “easy.” The mobility subdomain of FIM (FIM-mobility), the Functional Ambulation Classification (FAC), the 6-minute walk test (6MWT), and the 10-meter walk test (10MWT) were used to evaluate and elucidate the validity of the ABILOCO-Benin scale.

Results: Successive Rasch analyses led to the selection of 15 items that define a unidimensional, invariant, and linear measure of locomotion ability in stroke patients. This modified version of the ABILOCO scale, named ABILOCO-Benin, showed an excellent internal consistency, with a Person Separation Index of .93, and excellent test-retest reliability with high intraclass correlation coefficients of .95 (P<.001) for item difficulty and .93 (P<.001) for subject measures. It also presented good construct validity compared with FAC, FIM-mobility, 6MWT, and 10MWT (r≥.75, P<.001).

Conclusions: ABILOCO-Benin presents good psychometric properties. It allows valid, reliable, and objective measurements of locomotion ability in stroke patients.

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Stroke can result in functional disability and is a major cause of death.1,2 Even after receiving multidisciplinary health care to promote recovery, many stroke survivors will face long-term disabilities, including limitations in walking and movement. Walking ability is considered fundamental for activities of daily living and social participation,2 reflecting an individual’s health and functional states.1 It is a crucial goal during post-stroke rehabilitation. Therefore, efficient monitoring of gait recovery throughout the rehabilitation process is important for health care providers and patients.

Locomotion ability can be assessed through different methods, including gait analysis, walking performance observation, and walking ability self-report. There are a number of walking performance tests such as the 10-meter walk test (10MWT),3 the 6-minute walk test (6MWT),4 the 12-step ascend and descend test,5 and the shuttle walk test.6 However, while gait analysis is expensive, walking performance tests can be time-consuming in clinical settings. Moreover, although they are useful for treatment planning and clinical research, these data might not be related to patients’ walking ability during daily life in their environment.7 By contrast, a questionnaire-based assessment of walking ability is inexpensive, is time-saving, is easy to implement in nearly any context, and takes the patient’s environment into account.
Consequently, patient- or clinician-reported outcome measures are increasingly being suggested as instruments to evaluate health status in general, and locomotion ability specifically. There are several questionnaires to assess locomotion ability in post-stroke patients, such as the Functional Ambulation Classification (FAC), the Rivermead Mobility Index, the modified Emory Functional Ambulation Profile, the Functional Walking Category, the mobility subdomain of the FIM (FIM-mobility), and ABILOCO, to name a few.

ABILOCO is one of the most recent outcome measures designed to assess functional locomotion ability specifically in stroke patients. It is a Rasch-built, unidimensional self-reporting scale that provides linear measures. Being developed from the Rasch model, this scale opens up the opportunity to validly apply parametric statistics. Moreover, the Rasch model had allowed examining essential methodological aspects of scaling, including dimensionality (number of traits being measured), response category discrimination (the way response options are used), and scale invariance (absence of items bias). Nevertheless, this scale cannot be used in any context without prior validation. According to the International Classification of Functioning, Disability and Health framework, the activity domain to which locomotion ability belongs is influenced by environmental context and personal factors. Therefore, an activity-based questionnaire (eg, ABILOCO) must be revalidated before being used as a practical tool in a context that is socioculturally different from the context in which it was developed. This cultural adaptation should not be limited to only the translation of items and examination of the convergent validity of the scale. Categories discrimination, instrument invariance regarding context-specific factors of individuals, and item redundancy should be reevaluated in the new population.

The aim of the present study was to calibrate and validate a new version of the ABILOCO scale for stroke patients in Benin, a West African country where 4600 in 100,000 individuals have had a cerebrovascular accident, and where the mean ± SD age at stroke occurrence has been described to be 56±13 years old. Therefore, in Benin, as is the case in most African countries, stroke is a leading cause of long-term disability for adults in which gait recovery is crucially essential to retrieve optimal functional independence.

Methods

Participants

Stroke patients were recruited from 9 rehabilitation centers in Benin (West Africa) and enrolled if they had (1) no other pathologic disorders likely to affect their locomotion ability, and (2) no major cognitive deficiency likely to affect self-report. The study population (N=230); mean age ± SD, 51.1±11.6y; sex, 64.3% men; mean ± SD time since stroke, 21.9±25.4mo; paretic side, 53.5% left; phase of stroke, 67% chronic; 17.8% analphabetic, 21.7% primary school, 35.2% secondary school, 25.2% university) included both inpatient and outpatient participants. Patients who had already been discharged from the rehabilitation facility were recruited from patient registers. Participants performed the 6MWT by walking as quickly as possible on a flat ground square path with a 50- to 85-m perimeter marked on the floor. They were allowed to stop and rest when necessary. Patients were informed of the time after 2, 4, and 5 minutes, and the distance walked was recorded to the nearest meter. For the 10MWT, the time a subject spent walking a 10-m distance on a linear pathway at a comfortable speed was recorded. The ratio between the predefined distance and the recorded time corresponds to the subject’s usual walking speed.

This study was approved by the local ethics committees of participating rehabilitation centers and hospitals in Benin. All patients consented to participate.

ABILOCO-Benin questionnaire development

We used the French version of a preliminary pool of 43 items from Caty et al. As described in their original article, item selection was based on a review of existing scales and on the clinical experience of rehabilitation specialists (physical therapists, physicians, etc), assuming that retained items corresponded to the International Classification of Functioning, Disability and Health definition of locomotion. This preliminary questionnaire was submitted to Benin physical therapists (n=7) and physicians (n=2) working in the neurorehabilitation field for at least 3 years. These experts were asked to select all items that were not relevant to daily life in Benin from a preliminary list and to add new items, if appropriate. No new items were added, but 7 items were selected as not relevant in Benin context (eg, “doing ice-skating,” “going up an escalator alone,” “taking the train or the underground railway”).

After these 7 items were deleted, the final survey of 36 items was submitted to stroke patients, who were asked to rate the items as “impossible,” “difficult,” or “easy” (scored as 0, 1, or 2, respectively) to perform. To avoid response bias, the 36 items were presented in a random order. Activities never performed or not performed during the last 3 months were identified as unfamiliar and indicated as a missing response. A patient with a high score was presumed to have high locomotion ability. Study participants were interviewed in French or local languages by 2 of the authors (E.S.S., C.S.B.). However, for publication purpose, these items were translated into English using a back/forward translation method.

Rasch analysis and item selection

The Rasch model and its applications and advantages have been described in detail in the literature. In short, the Rasch analysis tests whether data from a scale satisfy the rules for constructing interval scale measurement. Rasch analysis allows interval-level measurements to be constructed from ordinal-level rating scale data, by converting the total ordinal raw scores into a quantity of constant unity (logits), repeated along a continuum.

In the present study, the Rasch analysis was based on the Rasch Unidimensional Measurement Model 2030 software. Items were selected based on 6 criteria applied in sequence as follows, under the partial credit model:

1. Items that had a missing response rate of ≥20 were considered as irrelevant to patients’ daily lives and were removed.

**List of abbreviations:**

- DIF: differential item functioning
- FAC: Functional Ambulation Classification
- ICC: intraclass correlation coefficient
- 6MWT: 6-minute walk test
- 10MWT: 10-m walk test

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2. An ordered rating scale was used to examine whether the 3 categories of responses (ie, “impossible,” “difficult,” “easy”) were well-discriminated across all items. These categories defined 2 consecutive thresholds (between “impossible” and “difficult,” and between “difficult” and “easy”), where a threshold corresponds to a location where a subject has an equal probability (50%) of scoring in adjacent categories. When thresholds are reversed, the subject with a higher ability may score lower than subjects with lower abilities. Items with reversed thresholds were deleted.

3. The item and person to fit the model were verified by 2 parameters: items with chi-square $P < 0.05$ were deleted, and only items that showed a residual value of $\pm 2.5$ were considered to fit the model and were retained.

4. Differential item functioning (DIF) was used to check the invariance property of the scale regarding sample characteristics, such as age ($\leq 53$ y, $>53$ y), sex (male, female), language of test administration (French, national languages), stroke phase (acute, chronic), paretic side (left, right), and walk speed ($\leq 0.55$ m/s, $>0.55$ m/s). Items that showed DIF according to the Bonferroni-adjusted $P$ value were deleted. The Bonferroni-adjusted $P$ value was obtained as $0.05$ divided by the number of comparisons.

5. Response to any item should not be biased by a response to another item. Local dependency was checked by analyzing residual correlations between items, considering correlations of $\leq 0.2$ as acceptable.

6. When several items had the same location on the continuum, the best-fitted item was retained. Finally, the dimensionality of the scale was assessed based on the overall fit statistics and a principle component analysis of the residuals combined with an individual $t$ test approach.

Test-retest reliability and construct validity investigation

A subsample of 110 patients was reassessed to investigate the test-retest reliability of the ABILOCO-Benin scale. Acute poststroke patients were reassessed within 3 days of the first evaluation, and chronic stroke patients were reassessed within 2 weeks after baseline assessment. The overall mean $\pm SD$ length of time between the 2 administrations was $8.8 \pm 6.6$ days. Convergent validity was tested by analyzing the degree of correlation between the ABILOCO-Benin questionnaire and the FAC, the FIM-mobility, the 10MWT, and the 6MWT.

Statistical analysis

Rasch analysis was conducted under the partial credit model because the metric distance between thresholds was not expected to be necessarily equal across all items. Using this model allows each item to function without restriction, in respect with variability in scoring range across items. DIF and test-retest reliability were investigated by using analysis of variance and the intraclass correlation coefficient (ICC). DIF analysis was done in Rasch Unidimensional Measurement Model 2030 with a minimum of 75 subjects per subgroup. Relations between ABILOCO-Benin and the 6MWT or 10MWT, and between ABILOCO-Benin and the FAC or FIM-mobility were investigated with Pearson and Spearman correlations, respectively. A $P$ value of $< 0.05$ was defined as statistically significant. Statistical analysis was performed with SPSS® and SigmaPlot® software programs.

Results

Scale calibration

After successive analyses, 21 items were deleted from the original 36 items. Two items were deleted because of important missing data (ie, “biking” [30.4%] and “jumping rope” [36.5%]), and 2 others because of reversed thresholds (ie, “walking with the assistance of 2 persons who support” and “walking less than 5 m, alone without assistance of a person”). Then 15 items not fitting the model (eg, “riding a stationary bicycle”) or showing DIF (eg, “walking alone more than 5 m, indoors, on a flat ground without help” and “going up and down stairs without holding onto handrail”) were deleted. Finally, 2 items were deleted because of local dependence. Note that DIF analyses were done only after deleting items that showed misfit. The 15 retained items showed good power of fit. The fit residuals (mean $\pm SD$) for items and persons were $0.1 \pm 0.85$ and $-0.26 \pm 0.64$, respectively. The item-trait interaction was not significant ($\chi^2_{10} = 18.3, \chi^2$ probability = 0.95). This result indicated that the 15 hierarchical items did not vary across the trait, and hence, met the required invariance property. The Person Separation Index was 0.93, indicating an excellent internal consistency of the scale. Application of the principle component analysis of the residuals and the individual $t$ test approach revealed that the 2 sets of items that were found to load positively and negatively did not give a significantly different person estimate. The proportion of $t$ tests outside the range was only 6.5% with a confidence interval of 3.7% to 9.3%, indicating that ABILOCO-Benin can be considered to be a unidimensional scale.

Table 1 shows the item locations with the associated SE, chi-square fit statistic and probability, and residual fit. “Walking less than 5 m, indoors, hanging onto pieces of furniture” was the easiest item ($-4.24$ logits). The most difficult item ($4.16$ logits) was “hopping on the paretic foot only without support.” The chi-square probability ranged from 0.21 to 0.90. The fit residual ranged from $-1.49$ to 0.89. These results indicated that all 15 items fit the model and defined an invariant and unidimensional scale of locomotion ability in Benin poststroke patients.

Test-retest reliability and construct validity

The analysis showed excellent correlations between the first and second assessments for both item difficulty (ICC = 0.95; $P < 0.001$) and person location (ICC = 0.93; $P < 0.001$). This result indicated that the ABILOCO-Benin scale presented excellent test-retest reproducibility, ensuring consistent measures of locomotion ability (fig 1). Relationships between ABILOCO-Benin measures and other selected locomotion assessment tools (fig 2) were as follows: FAC ($r = 0.86; P < 0.001$; $n = 223$), FIM-mobility ($r = 0.87; P < 0.001$; $n = 157$), 6MWT ($r = 0.76; P < 0.001$; $n = 193$), and 10MWT ($r = 0.75, P < 0.001$; $n = 192$). These high and significant correlations demonstrate the validity of the ABILOCO-Benin scale in assessing locomotion in stroke patients.

Finally, supplemental figure S1 (available online only at http://www.archives-pmr.org/) presents the structure of the ABILOCO-Benin scale through targeting, a threshold map, and the relationship between total raw scores and corresponding linear measures, whereas supplemental figure S2 (available online only at http://www.archives-pmr.org/) illustrates the invariance of the item hierarchy regarding personal factors. Additionally, supplemental table S1 (available online only at http://www.archives-pmr.org/)
is a conversion table of ABILOCO-Benin ordinal scores into linear measures expressed either in logits or in a percentage.

**Discussion**

The purpose of this study was to validate the ABILOCO-Benin, an assessment tool of locomotion ability in Benin poststroke patients. From an initial set of 36 items, 21 items were deleted during the calibration process, leading to the final retention of 15 items scored on a 3-level scale. Through Rasch analysis, several key points were investigated, including the internal construct validity for unidimensionality, appropriate category discrimination, and item invariance. Our results indicate that the ABILOCO-Benin is a self-reported, unidimensional, linear, and invariant scale that shows excellent reliability (internal consistency and test-retest reproducibility) and excellent construct validity.

Compared with FIM-mobility, FAC, 10MWT, and 6MWT, ABILOCO-Benin presented some important advantages. Whereas the 2 former scales are ordinal and the 2 latter tests are time-consuming, ABILOCO-Benin is a simple, easy, self-reported, and time-saving linear outcome measure. Being a Rasch-built scale, it provides linear and objective measures with the associated SE of measurement, which

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### Table 1  Item calibration and individual item fit of the ABILOCO-Benin questionnaire

<table>
<thead>
<tr>
<th>Items</th>
<th>Location (Logits)</th>
<th>SE (Logits)</th>
<th>Fit Residual</th>
<th>( \chi^2 )</th>
<th>df</th>
<th>( \chi^2 ) Probability*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Walking less than 5m, indoors, hanging onto pieces of furniture†</td>
<td>−4.24 .34</td>
<td></td>
<td>−0.22</td>
<td>0.88</td>
<td>2</td>
<td>.65</td>
</tr>
<tr>
<td>2. Walking more than 5m with assistive device (eg, cane)</td>
<td>−3.18 .30</td>
<td></td>
<td>−0.31</td>
<td>0.22</td>
<td>2</td>
<td>.90</td>
</tr>
<tr>
<td>3. Walking with the help of a person who guides but does not support†</td>
<td>−3.10 .24</td>
<td></td>
<td>−1.34</td>
<td>2.18</td>
<td>2</td>
<td>.34</td>
</tr>
<tr>
<td>4. Walking outdoors on a flat ground without assistive device</td>
<td>−1.39 .19</td>
<td></td>
<td>−1.36</td>
<td>3.13</td>
<td>2</td>
<td>.21</td>
</tr>
<tr>
<td>5. Turning and walking in a narrow space without support†</td>
<td>−0.62 .16</td>
<td></td>
<td>−1.16</td>
<td>0.68</td>
<td>2</td>
<td>.71</td>
</tr>
<tr>
<td>6. Striding over an object with the healthy foot first†</td>
<td>−0.30 .15</td>
<td></td>
<td>0.85</td>
<td>1.05</td>
<td>2</td>
<td>.36</td>
</tr>
<tr>
<td>7. Walking while holding a fragile object (eg, a glass full of water)†</td>
<td>−0.20 .15</td>
<td></td>
<td>0.21</td>
<td>1.62</td>
<td>2</td>
<td>.45</td>
</tr>
<tr>
<td>8. Going up and down stairs holding onto handrail</td>
<td>−0.02 .15</td>
<td></td>
<td>0.76</td>
<td>0.22</td>
<td>2</td>
<td>.90</td>
</tr>
<tr>
<td>9. Going down stairs putting both feet on each step without handrail</td>
<td>0.23 .14</td>
<td></td>
<td>−0.27</td>
<td>1.13</td>
<td>2</td>
<td>.57</td>
</tr>
<tr>
<td>10. Going up stairs putting each foot on the next step without handrail‡</td>
<td>1.15 .13</td>
<td></td>
<td>−1.49</td>
<td>2.53</td>
<td>2</td>
<td>.28</td>
</tr>
<tr>
<td>11. Walking backwards without support†</td>
<td>1.24 .14</td>
<td></td>
<td>−1.35</td>
<td>0.90</td>
<td>2</td>
<td>.64</td>
</tr>
<tr>
<td>12. Kicking a ball with the paretic foot</td>
<td>1.43 .14</td>
<td></td>
<td>0.89</td>
<td>0.46</td>
<td>2</td>
<td>.80</td>
</tr>
<tr>
<td>13. Walking several minutes at a constant speed</td>
<td>1.58 .14</td>
<td></td>
<td>0.18</td>
<td>1.99</td>
<td>2</td>
<td>.37</td>
</tr>
<tr>
<td>14. Running on a flat and level ground</td>
<td>3.25 .13</td>
<td></td>
<td>−0.21</td>
<td>0.29</td>
<td>2</td>
<td>.86</td>
</tr>
<tr>
<td>15. Hopping on the paretic foot only without support</td>
<td>4.16 .16</td>
<td></td>
<td>0.08</td>
<td>1.05</td>
<td>2</td>
<td>.59</td>
</tr>
</tbody>
</table>

* Bonferroni-adjusted probability value (level: .003).
† Common item between ABILOCO-Benin and the original scale.

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![Fig 1](www.archives-pmr.org)  Test-retest reliability of ABILOCO-Benin as reproducibility of subject measures (A) and item hierarchy (B) between the first and second assessments. In both panels, the 95% confidence interval of the ideal invariance is indicated by solid lines.
are very useful aspects in clinical trials. By evaluating how patients perceive the difficulty of performing activities, this scale takes into account the habitual lifestyles of patients, including the environment where they move. In contrast, the 10MWT and 6MWT measure walking performance in standard conditions (level ground without obstacles). These conditions do not always reflect daily life, where patients may encounter obstacles (nonlevel surfaces, slope, stairs, etc) and may have to react to unexpected perturbations while walking.

The ABILOCO-Benin, administered as a self-reported questionnaire, showed excellent internal consistency and excellent test-retest reliability. As a method of observation, self-report is frequently used in rating scales because it allows numerous activities to be assessed in a short time. Self-report touches the real context of the patient’s life and most likely represents the ultimate impact of the disability on the patient’s daily life.

Compared with the Belgian version of ABILOCO for adult poststroke patients, the ABILOCO-Benin had some positive differences. It encompassed more items (15 vs 13), with a response format of 3 well-discriminated categories, resulting in better sensitivity and patient discrimination. These differences can be explained by the sample size and, more importantly, by the difference in the distribution of patients. While the previous study by Caty included only 100 subjects whose time since stroke ranged from .25 to 60 months, our study included a high number of patients (N = 230) with time since stroke ranging from .25 to 156 months, presenting a wider range of locomotion ability. ABILOCO-Benin will allow better monitoring of gait recovery in the neurorehabilitation of poststroke patients in Benin and is expected to be adapted for other African countries. Having 7 common items, both the original Belgian ABILOCO and the new adapted ABILOCO-Benin provide a solid basis for multicenter trials involving African and European centers. Future studies could investigate how both versions of ABILOCO can be linked on the same continuum of locomotion ability based on their common items.

The revision of ABILOCO highlights once again that caution should be taken when selecting instruments for functional assessment from patients’ perspectives. Indeed, patients’ needs and perspectives change according to their environment and habitual lifestyle. As a consequence, before using a patient-reported outcome measure in a context that is different from the context where it has been developed, the instrument should undergo a validation process that involves testing a series of assumptions including category discrimination, hierarchy of items, local response dependency, and unidimensionality. Recently, a Korean version of ABILOCO was published. The development of the Korean version of ABILOCO consisted in translating the 13 items into Korean and investigating the intra- and interrater reliability. Our study highlights that translation may not be enough. Each instrument designed to measure latent variables should go through an examination of categories discrimination, scale invariance regarding context-specific factors of the new population, before the testing of classic psychometric qualities such as reliability, validity, and responsiveness. Indeed, item selection while developing a scale is based not only on statistical decision, but also on examination of whether a given item is relevant to the and the 10MWT (D). Plots demonstrate the good convergent validity of the ABILOCO-Benin scale, highlight a ceiling effect of FIM-mobility, and show a floor effect of 6MWT and 10MWT. \( \rho \) and \( r \) indicate Spearman (FAC and FIM-mobility) and Pearson (6MWT and 10MWT) correlation coefficient, respectively.
population it intends to measure. In our study, some items were deleted that were part of the 13 calibrated items of the original ABILOCO because they did not appear to be relevant in the context of Benin. In addition, during the calibration process, some items were deleted because of redundancy, a high amount of missing responses, DIF, or misfit. However, the reason why some items appeared to misfit the Rasch model was not always clear. It is possible that local dependence between items had caused the misfitting of some items. That is, these items might have been deleted either for misfit or for local dependence reasons.

Study limitations

The present study focused on the development and validation of the ABILOCO-Benin scale. We did not evaluate the ability of this scale to measure clinical change resulting from spontaneous or posttreatment recovery. This particular property, called responsiveness, should be investigated in further studies. Moreover, this ABILOCO-Benin scale was calibrated based on a stroke population from a single West African country. The cross-country validity of this first African version of ABILOCO needs to be confirmed by testing its invariance in other African countries.

Conclusions

The ABILOCO-Benin scale is a unidimensional, linear, and invariant Rasch-built scale designed to assess the locomotion ability of poststroke patients in Benin. This modified version of ABILOCO contains 15 items of 3-level categories that are scored based on stroke patients’ perceptions of the difficulty encountered when performing daily activities that require use of the lower limbs. The test is very easy to administer, on either a self-report basis or an interview basis, and takes no longer than 5 minutes. This scale is highly valid and reproducible over time, with high discrimination power.

Suppliers

a. RUMM Laboratory Pty Ltd, 14 Dodonaea Ct, Duncraig, WA, Australia 6023.
b. SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.c. Systat Software Inc, 1735 Technology Dr, Ste 430, San Jose, CA 95110.

Keywords

Locomotion; Outcome assessment; Rehabilitation; Stroke; West Africa

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Supplemental Fig S1  Structure of the ABILOCO-Benin scale presented in 3 panels. The bottom panel shows the relationship between the total raw scores (0–30) and the corresponding linear scores (range, −6.82 to 6.23 logits). This relationship allows the locomotion ability of a given patient to be obtained in logits as a linear measure. The middle panel (or threshold map) illustrates the functional categorical responses of items as a function of locomotion ability. Categorical responses were well-ordered, defining an increasing measure of locomotion ability. From this threshold map, the expected response of individuals to any item can be predicted based on their locomotion ability. For example, a subject with a locomotion ability of 0 logits is expected to report the 4 easiest items as being “easy,” the 5 following items as being “difficult,” and the 6 most difficult items as being “impossible” to perform. Eight patients of our sample reported being able to perform all the activities easily, and 7 patients were unable to perform any of the items. Finally, the distribution of the subjects (top panel) indicated that the average locomotion ability of our sample (1.46 logits) was higher than the average difficulty of the items (by convention, 0 logits).
Supplemental Fig S2  Invariance of the ABILOCO-Benin scale tested by comparing the hierarchy of items in the dichotomous subgroups of patients through 6 criteria: age, sex, affected side, language of test administration, spontaneous walking speed, and stroke phase. More difficult items are in the top right. Solid lines indicate 95% confidence intervals of ideal invariance. Items within solid lines were ranked with similar hierarchy in patient subgroups. No significant DIF was observed, despite the minor exceptions of items lying outside the 95% confidence intervals. Abbreviation: y.o., years old.
### Supplemental Table S1  Conversion table from ordinal scores to interval measures of the ABILOCO-Benin scale

<table>
<thead>
<tr>
<th>Ordinal Sum Scores</th>
<th>Interval Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Logits</td>
</tr>
<tr>
<td>0</td>
<td>−6.82</td>
</tr>
<tr>
<td>1</td>
<td>−5.57</td>
</tr>
<tr>
<td>2</td>
<td>−4.63</td>
</tr>
<tr>
<td>3</td>
<td>−3.92</td>
</tr>
<tr>
<td>4</td>
<td>−3.38</td>
</tr>
<tr>
<td>5</td>
<td>−2.93</td>
</tr>
<tr>
<td>6</td>
<td>−2.54</td>
</tr>
<tr>
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**NOTE.** This conversion table of ABILOCO-Benin allows converting ordinal scores into linear measures expressed either in logits or in percent. It has been designed to enable the use of the ABILOCO-Benin scale by those who are not familiar with Rasch measures. It can be used as a nomogram that facilitates the translation of ordinal scores to interval. Nonetheless, note that this conversion table can be appropriately used only if the patient answers all items. If some responses are missing, the online analysis, which will be available at [www.rehabscales.org](http://www.rehabscales.org), will allow direct translation of ordinal scores into linear Rasch measures of locomotion ability. This open access online measure will be helpful to determine a patient’s measure and associated SE by taking into account missing values.