Brazilian version of the Hammersmith Functional Motor Scale Expanded: cross-cultural adaptation and validation

Versão brasileira da Hammersmith Functional Motor Scale Expanded: adaptação transcultural e validação

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Abstract

Background The Hammersmith Functional Motor Scale Expanded (HFMSE) has been widely used to assess the motor function of patients with spinal muscular atrophy (SMA) older than 2 years, with the ability to sit and/or walk.

Objective To translate, cross-culturally adapt and validate the HFMSE to Brazilian Portuguese.

Methods The translation process and cross-cultural adaptation followed international guidelines recommendations. The reliability and applicability of the Brazilian version consisted of the application of the HFMSE (in Brazilian Portuguese) to 20 patients with types 2 and 3 SMA. Two examiners assessed the participants for interrater reliability, through the analysis of Kappa reliability agreement (k) and intraclass correlation coefficient (ICC).

Results The HFMSE was successfully translated and cross culturally adapted to Brazilian Portuguese. Twenty participants with types 2 and 3 SMA were enrolled in the study (type 2 = 6; type 3 = 14). The ICC for the total score showed very high reliability (ICC =1.00), and the reliability of each of the items individually was considered excellent (Kappa > 0.80).

Conclusion The Brazilian version of the HFMSE proved to be valid and reliable for the evaluation of SMA patients older than 2 years with the ability to sit and/or walk.

Keywords
- Motor Activity
- Muscular Atrophy, Spinal
- Validation Study

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Resumo

Antecedentes A *Hammersmith Functional Motor Scale Expanded* (HFMSE) tem sido amplamente utilizada para avaliar a função motora de pacientes com atrofia muscular espinhal (AME) maiores de dois anos, com capacidade de sentar e/ou andar.

Objetivo Traduzir, adaptar transculturalmente e validar a HFMSE para o português brasileiro.

Métodos A tradução e a adaptação transcultural seguiram as diretrizes internacionais. A confiabilidade e a aplicabilidade da versão brasileira consistiram na aplicação da HFMSE (em português brasileiro) em 20 pacientes com AME tipos 2 e 3. Dois examinadores avaliaram os participantes quanto à confiabilidade interexaminadores, por meio da análise da concordância de confiabilidade Kappa (k) e do coeficiente de correlação intraclasse (*intraclass correlation coefficient* [ICC]).

Resultados O processo de tradução e adaptação transcultural da HFMSE para o português brasileiro foi concluído com sucesso. Vinte participantes com AME tipos 2 e 3 foram incluídos no estudo (tipo 2 = 6; tipo 3 = 14). O ICC para o escore total apresentou confiabilidade alta (ICC = 1.00) e a confiabilidade de cada um dos itens individualmente foi considerada excelente (K > 0,80).

Conclusão A HFMSE (PT-BR) mostrou-se válida e confiável para a avaliação de pacientes com AME, com mais de dois anos de idade e com capacidade de sentar-se independentemente e/ou andar.

Palavras-chave

- Atividade Motora
- Atrofia Muscular Espinhal
- Estudos de Validação

INTRODUCTION

Spinal muscular atrophy (SMA) is a genetic and neuromuscular disease, caused by deletion or mutation of the Survival motor neuron 1 (SMN 1) gene, located on chromosome 5q.[1] The reduction of SMN protein leads to dysfunction and loss of spinal anterior horn motor neurons, with consequent weakness and muscle atrophy.[1,2] The incidence of SMA in Brazil is unknown, but the incidence in the worldwide population is around 1–10.000 live births.[3]

SMA manifests in a wide variety of phenotypes, which can be classified into four clinical types, according to the maximum motor function achieved and age at onset of symptoms.[3] Unlike type 1 SMA, in which rapid deterioration occurs, type 2 and 3 SMA progresses slowly, so the motor functional decline can be difficult to detect over short periods.[4] In addition, patients range from the weakest who can lose the ability to sit independently throughout life to the other extreme from strong patients to patients who stand and walk unaided.[5] Currently, one of the main challenges is to establish clinical assessment instruments for patients with type 2 and 3 SMA, due to the relatively slow progression and great variability of these forms.[6]

In SMA types 2 and 3, motor function is considered the primary outcome in clinical trials.[6] Motor function assessments consist of items in which the patient is asked to perform movements or motor activities. The quality of performance for each item is considered by the physiotherapist evaluator, who will score on a predetermined rating scale. In general, motor function assessment instruments vary between "did not perform," "performed, but with compensation" or "performed perfectly"[7]. The scales involve the domains of the International Classification of Functioning, Disability and Health (ICF), including the domains of structure and function, activity and participation.[8]

Several instruments have already been developed with the aim of monitoring the motor function of patients with neuromuscular diseases.[8] Currently, the Hammersmith Functional Motor Scale Expanded (HFMSE) is one of the internationally recognized scales as a specific outcome measure for SMA in clinical trials, which allows the assessment of patients with type 2 and 3 SMA.[9–11]

The development process of the Hammersmith Functional Motor Scale (HFMS) began in 2003 by Main and collaborators. Until then, the scale consisted of 20 items, which allowed the assessment of motor function only in non-ambulatory patients.[12] Considering that SMA represents a heterogeneous group of patients, there was a need for a measure of motor function that could assess both ambulant and non-ambulant patients.[9] Therefore, in 2007, O'Hagen and collaborators developed the expanded version of the HFMS. The HFMSE was developed from an additional module based on 13 items from the Gross Motor Function Measure (GMFM), which allows the assessment of skills observed in ambulant patients with SMA.[13]

Nowadays, the use of new therapies that modify the natural history of SMA 5q has been approved in different countries, including Brazil. Evaluating the response of these medications in the real world is essential to confirm their benefit in each patient.

Given the current scenario of rapid change in SMA, due to the prospects of new therapeutic approaches, translated and validated instruments available for use in clinical practice become more important.[6] In recent years, the HFMSE has proven to be valid and reliable.[14,15]

Thus, the objective of the present study was to provide the translation and cross-cultural adaptation of the HFMSE scale, so that it becomes a translated and validated instrument for Portuguese, capable of evaluating ambulant and non-ambulant patients.

METHODS

Design

This was a cross-sectional observational study, approved by the Federal University of Minas Gerais and its Ethics Committee (30531319.3.0000.5149). Furthermore, all participants and legal guardians signed a consent form. This study was divided into two phases (►**Figure 1**): the first consisted of a process of translation and cross-cultural adaptation of the original HFMSE, and the second consisted of the application of the HFMSE (in Brazilian Portuguese) in the population of patients with type 2 and 3 SMA.

HFMSE description

The HFMSE is a specific measurement scale developed to assess motor function in ambulant and non-ambulant SMA patients.[13] The scale can be used in children from 30 months to adulthood.[8] It consists of 33 items, scored on a three-point scale. A score of two (2) represents the ability to perform the item without any modification/adaptation, one (1) performs the item with modification/adaptation and zero (0) is not able to perform the motor task proposed by the item. The final score of 66 points corresponds to the sum of all items. The higher the score, the better the patient's motor function for the performance of functional skills.[13] Its validity and reliability have already been demonstrated.[15] HFMSE can be completed in ~30 minutes.[16] The first part of the scale comprises functional skills from sitting independently to taking 4 steps. The second part involves functional skills such as kneeling, jumping, and going up and down stairs. To apply the scale, a form and application manual, a mat, a bench with adjustable height, a ladder with at least four steps, a ruler, and an adhesive tap are required.[13]

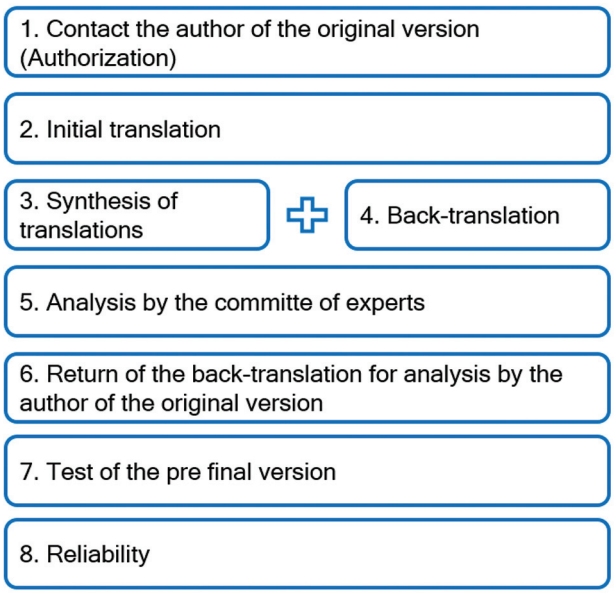

Figure 1 Process of transcultural translation and adaptation of HFMSE into Brazilian Portuguese.

Translation and Cross-Cultural Adaptation of the HFMSE (in Brazilian Portuguese)

The process of translating and transcultural adaptation of the HFMSE into Portuguese followed standardized procedures (►**Figure 1**), in accordance with recommendations from international guidelines and previous studies.[17,18]

The first phase of the process was the authorization of the author of the original version of the HFMSE. Contact was made with the author to give permission and monitor the whole process of translation and cross-cultural adaptation to Brazilian Portuguese.

The original version of the instrument was translated from English into Portuguese by two independent bilingual translators (one health care professional), who have Portuguese as their mother language and fluency in English. This step results in two different translations, which are forwarded to the synthesis process. The synthesis of the translations was performed between the translators and the project coordinator (specialist researcher). This step aimed to detect errors and divergent interpretations, generating the first version in Portuguese.[18]

To verify that the version in Portuguese reflected the same meaning as the original scale, the first version went through the process of back-translation by a professional translator, unfamiliar with the original scale. After, the back-translation went through a committee of five research physiotherapists with experience in neuromuscular diseases to compare the two versions and discussed changes in terms or expressions and possible corrections.[18]

The version obtained after back-translation and review by members of the research committee was returned to the author of the original version, accompanied by a report of the translation process. The author of the original version approved the translation after minor suggestions and adjustments.[17]

To detect small errors (typing, formatting) that remain and to observe the operational equivalence, the version final version was used for the pre-test stage with four participants.[18] Out of the four participants included in the pilot test, half were male ($n=2$), equally divided between type 2 ($n=2$) and type 3 SMA ($n=2$). Three participants were wheelchair users ($n=3$) and one walked ($n=1$). The mean age of pilot test participants was 13.5 ± 3.7 years.

Reliability

To assess the quality, reliability, and applicability of the Brazilian Portuguese version of the HFMSE, the instrument was applied to participants with SMA.[19] This step was performed by two evaluators, both physiotherapists, with extensive experience in SMA, evaluation of motor function and previously trained in the application of the HFMSE. Evaluator 1 was a master's student and was responsible for evaluating each participant using the translated version of the HFMSE. Evaluator 2 was a PhD and was responsible for reviewing and scoring the videos for each item. The interexaminer reliability step was

performed using videos to avoid multiple assessments in a short period of time, as patients with SMA fatigue easily. The individual scores of the items and the final score were recorded, as well as the time required to complete the HFMSE (in Brazilian Portuguese), subtracting the start time from the end time of the assessment.

As in the validation study of the HFMSE, developed by Glanzman and collaborators in 2011, before the application of the HFMSE, all patients in the study received a functional classification, using an ordinal scale from 1 to 10 (►**Figure 2**).[13,20] On this ordinal scale, "10" indicates the ability to perform age-appropriate motor skills and "1" indicates an inability to sit independently.[13]

All patients from the Neuromuscular Diseases Outpatient Clinic of the Clinical Hospital of the Federal University of Minas Gerais (Brazil) with a confirmed clinical and genetic diagnosis for type 2 or 3 SMA were invited to participate in the study. The following were excluded from the study: patients without diagnosis confirmed by genetic study through MLPA and/or through NGS, patients unable to sit independently, and patients with medical conditions that influenced the understanding of motor scale movements. Among the thirty patients invited to participate in the study, twenty were included in the final sample. One participant was excluded due to lack of cooperation during the assessment (associated with autism disorder) and nine patients were excluded from the sample because although they were classified as type 2 SMA, they lost the ability to sit independently.

Statistical analysis

Descriptive statistics of the participants was reported as mean and standard deviation (SD), absolute (*n*) and relative (%) frequency, median (Q2) and quartiles (Q1 and Q3).[20]

1 Unable to sit independently
2 Sits independently
3 Pulls to sit
4 Supine to sit
5 Stands but does not walk
6 Takes >4steps (with or without braces and assistive devices)
7 Household ambulatory-with or without orthotics and assistive devices for 50 feet
8 Household ambulatory-with or without orthotics and assistive devices for >50 feet
9 Runs
10 Age-appropriate in motor skills

Note: Table Taken from the Study by O'Hagen et al., 2007, which Describes the Functional Classification Scale from 1–10.[13]
Figure 2 Functional Rating Scale (O'Hagen et al, 2007).[13]

The analysis of interexaminer reliability was performed using the Cohen's Kappa coefficient index (K) and intraclass correlation coefficient (ICC).[21] ICC values less than 0.40 indicate poor reliability; values between 0.41 and 0.75 are considered acceptable; values above 0.75 excellent reliability.[22] The Kappa index, values below 0.20 are considered as poor agreement, and values between 0.61 and 0.80, substantial and above 0.80 excellent reliability was considered.[23]

All analyses were performed using the SPSS 20.0 statistical software for Windows, with a significance level of $p < 0.05$.

RESULTS

The translated version of the HFMSE was reviewed by the research committee, being modified to correct some grammatical and translation errors. Some expressions, terms, and words were replaced with similar ones, such as the use of the term "plinth" and "mat table". In Brazil, plinth is understood as a high and narrow stretcher and mat table as a firm, low, and wider surface, widely used in physiotherapy clinics. Thus, whenever the term plinth was used in the original version, in the Portuguese translation it was translated as "*maca*". And for the term mat table, the translation into Portuguese was defined as "*tablado*". The use of the term "for a count of," in the literal translation into Portuguese would be "*pela contagem de*", however, this is not a term used in Portuguese. We understand that the author of the original version wants to show that 3 seconds is different from saying "and one – and two – and three." For this reason, we use the term "*enquanto conto até*".

The sample consisted of 20 participants, divided between 6 participants with type 2 (30%) and 14 participants with type 3 SMA (70%). Twelve female participants (60%), with a mean age of 15.8 ± 10.9 years, ranging from 3 to 45 years of age. Out of the total of 20 participants, 10 (50%) maintained the ability to walk and the other half were wheelchair users. Out of the total of 14 patients with type 3 SMA phenotype, four (28.6%) lost the ability to walk throughout their lives, already being wheelchair users at the time of evaluation. The sample characteristics are described in ►**Table 1**.

The HFMSE (in Brazilian Portuguese) showed very satisfactory interexaminer reliability, with an ICC equal to 1.00 (►**Table 2**). Likewise, Cohen's Kappa coefficient index for each of the 33 items showed that the concordance rates between the two examiners are considered excellent ($K > 0.80$) (►**Table 3**).

The execution time of the HFMSE (in Brazilian Portuguese) was recorded for each participant. A mean of 16.8 ± 7.1 minutes was obtained for the application of the HFMSE (in Brazilian Portuguese) in patients with type 2 SMA and 23.7 ± 6.4 minutes for type 3 SMA. The overall mean for both phenotypes was 21.6 ± 7.2 minutes, ranging from 8 to 34 minutes.

The average degree of functionality (1–10) of the participants included in the sample was 5.9 ± 2.5 points (minimum: 2.0; maximum: 9.0).

Table 1 Characteristics of the sample

	SMA 2 (*N* = 6)	SMA 3 (*N* = 14)	All participants (*N* = 20)
Sex (F:M)	1:5	11:3	12:8
Age (years)	9.2 ± 5.4 (3.0–17.0)	25.8 ± 11.6 (8.0–45.0)	15.8 ± 10.9 (3.0–45.0)
HFMSE application time (minutes) Mean ± SD. (min–max)	16.8 ± 7.1 (9.0–28.0)	23.7 ± 6.4 (8.0–34.0)	21.7 ± 7.2 (8.0–34.0)
Maximal motor function Walker/ Non walker)	Walker: *N* = 0 (0%) Non walker: *N* = 6 (100%)	Walker: *N* = 10 (71.4%) Non walker: *N* = 4 (28.6%)	Walker: *N* = 10 (50%) Non walker: *N* = 10 (50%)
Functional rating Scale (1–10) Mean ± SD. (min–max)	2.0 ± 0.0 (2.0–2.0)	7.1 ± 1.9 (2.0–9.0)	5.9 ± 2.5 (2.0–9.0)

Abbreviations: F, Female; M, Male; min, minimum; max, maximum.

Table 2 Inter-rater reliability analysis of the total HFMSE score

	HFMSE Final score	
	Evaluator 1	Evaluator 2
Mean ± SD	20.1 ± 21.2	20.1 ± 21.1
Evaluator 1–2 (Mean ± SD)	-0.071 ± 0.38	
ICC (95%CI)	1.00 (1.00–1.00)	

Abbreviations: CI, confidence interval; ICC, intraclass correlation coefficients; SD, standard deviation.

Table 3 Agreement analysis regarding the evaluation of each HFMSE Item

Item	Kappa index	*p*	Item	Kappa index	*p*
1	1.00	< **0.001**	18	1.00	< **0.001**
2	1.00	< **0.001**	19	1.00	< **0.001**
3	1.00	< **0.001**	20	1.00	< **0.001**
4	1.00	< **0.001**	21	1.00	< **0.001**
5	0.94	< **0.001**	22	0.94	< **0.001**
6	0.94	< **0.001**	23	1.00	< **0.001**
7	1.00	< **0.001**	24	1.00	< **0.001**
8	1.00	< **0.001**	25	1.00	< **0.001**
9	1.00	< **0.001**	26	1.00	< **0.001**
10	1.00	< **0.001**	27	1.00	< **0.001**
11	1.00	< **0.001**	28	1.00	< **0.001**
12	1.00	< **0.001**	29	1.00	< **0.001**
13	1.00	< **0.001**	30	1.00	< **0.001**
14	0.93	< **0.001**	31	1.00	< **0.001**
15	1.00	< **0.001**	32	1.00	< **0.001**
16	1.00	< **0.001**	33	1.00	< **0.001**
17	1.00	< **0.001**			

Note: **p,** Significance Probability of Kappa Agreement Analysis.

DISCUSSION

The present study successfully translated the HFMSE into Brazilian Portuguese. The translation of the original version followed the international recommendations of Beaton et al., 2000 and Fortes and Araujo, 2019.[17,18] The HFMSE (in Brazilian Portuguese) is a valid instrument for assessing the motor function of patients with SMA.

This is the first study to translate and validate the measurement properties of the HFMSE for the Brazilian

population. The translation process aimed to maintain the technical and semantic equivalence of the original version in the native language. The small changes made were important for a better understanding of the HFMSE (in Brazilian Portuguese).

The interexaminer reliability for the total score showed a very satisfactory correlation coefficient (ICC = 1.00), as well as for each of the items individually with a Kappa agreement index > 0.80. Until now, the interexaminer reliability of the HFMSE had not yet been demonstrated by other studies, only the HFMS, with ICC = 0.95.[16,24]

The average time to perform the HFMSE (in Brazilian Portuguese) was 21.6 ± 7.2 minutes, ranging from 8 to 34 minutes. Comparing the mean time of execution of the HFMSE in patients with type 2 and 3 SMA, it was observed that in participants with mild functional impairment, the test can take up to 34 minutes, however, in more severe patients, with type 2 SMA it can be tested in ~9 minutes. This observation previously described in the literature is associated with items on the scale that cannot be performed due to the lower motor capacity of the most severely ill patients, reducing the number of applicable items and, consequently, a shorter application time.[25]

Based on the results of the present study, the HFMSE (in Brazilian Portuguese) demonstrated adequate validity and reliability for the evaluation of patients with type 2 or 3 SMA, who sit and/or walk. In recent years, the HFMSE has been the instrument internationally used to assess the motor function of patients with SMA in the clinic and as a measure of outcome in clinical trials, including patients with late-onset SMA, as described in CHERISH and SUNFISH trials.[26,27] Likewise, the HFMSE is a relevant assessment tool in real-life studies, allowing the monitoring of a wide range of patients with different characteristics, obtaining information on how treatments work in real-world conditions and providing complementary information to clinical trials.[28] Therefore its availability in Portuguese will allow the evaluation and measurement of results of clinical interventions, monitoring of the natural course of the disease, clinical trials and real-life studies in Brazil.

Although the sample size may seem small, considering that SMA is a rare disease, the sample size of 20 participants can be considered adequate. Similarly, the recent Portuguese translation and adaptation of the Children's Hospital of Philadelphia Infant Test of Neuromuscular Disorders (CHOP INTEND) scale, showed the same limitation, since they included only 13 patients with SMA type 1.[29] A possible limitation of this study was the impossibility of performing the interexaminer reliability in person, at the same time, due to the risk of patient fatigue. Fatigue is a disabling primary symptom of neuromuscular diseases and is not beneficial for patients with SMA.[30] However, although this may be a limitation, the method of evaluating inter-rater reliability through videos has already been used in another study.[16] Furthermore, a distance reliability protocol was adopted, with standardized and adequate filming.

In conclusion, through the study, it was possible to conclude that the Brazilian version of the HFMSE met the criteria of semantic equivalence and preserved the meaning of each item of the original HFMSE.

The HFMSE (in Brazilian Portuguese) proved to be valid and reliable for the evaluation of patients with SMA who sit and/or walk. Its availability in Brazil will facilitate the evaluation and measurement of the motor function of this specific group of SMA patients especially in the era of new therapies. The HFMSE manual and the scale were completely translated to Portuguese and can be easily used for different proposals including real-world patient evaluation and in clinical trials or rehabilitation studies (►**Supplementary Material 1** - https://www.arquivosdeneuropsiquiatria.org/wp-content/uploads/2024/04/ANP-2024.0059-Supplementary-Material-1.pdf and ►**Supplementary Material 2** - https://www.arquivosdeneuropsiquiatria.org/wp-content/uploads/2024/04/ANP-2024.0059-Supplementary-Material-2.pdf).

Authors' Contributions

ACMLM: conceptualization, methodology, project administration, data collection, formal analysis, writing-original draft, writing-review and editing. MBC, GPCS, CCP: methodology, data collection, critical review. JM: critical review and approval of the final version. JGG: conceptualization, methodology, formal analysis, drafting of manuscript, critical review. All authors discussed the results and contributed to the final manuscript.

Conflict of Interest

There is no conflict of interest to declare.

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