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EMHA migraine scoring system: A novel, valid, and reliable metric to capture severity, align with patients, and facilitate communication

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Abstract

Background: Available instruments to quantify migraine-related disability, such as the Headache Impact Test (HIT-6) and Migraine Disability Assessment Test (MIDAS), have certain limitations (e.g., recall bias, overlooking interictal burden), and do not always facilitate patient-doctor communication. We developed a migraine scoring system, namely the European Migraine and Headache Alliance–Migraine Scoring System (EMHA-MSS) with the aim of improving patient communication with healthcare professionals.

Methods: Cross-sectional, descriptive, quantitative study conducted between June 2024 and March 2025. First, we used exhaustive diary registries from 319 Spanish-speaking patients for a pilot study (of whom $n = 280$ had complete HIT-6/MIDAS). Second, the EMHA-MSS was administered to a validation cohort of Spanish patients ($N = 504$). Third, we undertook cross-language analyses using a separate English-language dataset from English-speaking patients ($N = 51$). The pilot benchmarking analyses used an exploratory three-item version of the scale with different scoring, whereas the final psychometric analyses used the four-item EMHA-MSS.

Results: The EMHA-MSS demonstrated unidimensional structure with excellent Confirmatory Factor Analysis fit (Comparative Fit Index = 1.000, Tucker-Lewis Index = 1.000, Root Mean Square Error of Approximation = 0.000, Standardized Root Mean Residual = 0.003). Acute treatment reliability was identified as the main factor driving

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reclassification between severity categories when comparing EMHA-MSS and HIT-6 or MIDAS (comparisons used an exploratory 3-item EMHA-MSS with different scoring in the pilot cohort). Our model provided an excellent fit, supported the expected factorial structure, and demonstrated that factor scores could be reliably calculated. The EMHA-MSS showed good to excellent test-retest reliability. Cross-language validity was demonstrated for the English version using configural and metric invariance, as well as partial scalar invariance.

Conclusion: The EMHA-MSS highlighted the importance of treatment reliability, pain and attack intensity, and frequency in classifying patients with migraine and evaluating the severity of the disease. This novel scoring system could facilitate tailored management and monitoring of migraine over time, potentially improving alignment with patients' perceptions and enhancing the understanding between them and healthcare providers.

Keywords

questionnaire, treatment effectiveness, pain intensity, reliability, test-retest

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Introduction

Migraine is a neurological disorder, defined by recurrent episodes of moderate to severe headache often accompanied by nausea, photophobia, and phonophobia.[1] The most recent Global Burden of Disease headache analysis (1990–2023) estimated a global age-standardized prevalence of 14.1% (95% uncertainty interval [UI]: 12.1–15.9) in 2023, confirming migraine as one of the most common neurological disorders worldwide. Prevalence was higher in females than males (17.6% vs 10.5%), with differential effects of sex hormones likely contributing to this higher burden in women, since peak burden occurs in both sexes between 30 and 39 years of age.[2,3]

Instruments, such as the Headache Under-Response to Treatment (HURT) questionnaire and the Migraine Treatment Optimization Questionnaire-5 (mTOQ-5), are designed to translate patient experiences into standardized scores.[4,5] These tools allow physicians to identify whether current treatment is effective and open a structured dialogue about therapy adjustments, thereby strengthening physician-patient communication. Other screening tools, like the Identify Chronic Migraine (ID-CM) questionnaire and its short-form, are validated for detecting chronic migraine in routine clinical settings.[6] They help identify patients with chronic migraine, unmet treatment needs, higher disability, and increased healthcare use, enabling tailored treatment strategies.[6,7] Additionally, the Headache Impact Test (HIT-6)[8] and Migraine Disability Assessment Test (MIDAS)[9] quantify migraine-related disability across work, social, and household domains, offering reliable, validated tools for assessing the multidimensional burden and guiding treatment decisions. Nevertheless, migraine is often classified dichotomously as episodic or chronic, which may not fully reflect severity or gradual change over time. Therefore, a dynamic, non-dichotomous tool is needed to track severity along a continuum and detect change during follow-up.

The MIDAS questionnaire relies on a three-month recall period and has demonstrated validity and reliability, although sensitivity to short-term change in migraine-related disability/impact may be limited.[10–12] HIT-6 also suffers from a recall bias (four weeks) and may vary considerably depending on when it is completed, which can limit its ability to track change and may not fully capture interictal burden between attacks.[13] Both questionnaires emphasize frequency and intensity but may miss broader health-related quality-of-life improvements, a critical part of overall burden.[14] They also may not capture short-term change or practical severity tracking for routine follow-up. Another limitation of many established PROMs is that they were not primarily developed as patient-facing communication tools or through consumer-led co-design. The European Migraine and Headache Alliance – Migraine Scoring System (EMHA-MSS) was co-developed with patient representatives and migraine experts to help patients describe migraine severity to healthcare professionals. Although this study did not assess stigma or healthcare-seeking behavior, the EMHA stigma survey supports this need: 93% of respondents reported poor public understanding of migraine and 35% delayed or avoided medical advice due to embarrassment or fear of judgment.[15] These findings support the broader need for tools that facilitate patient-clinician dialogue.

Therefore, our primary goal was to develop a migraine scoring system (EMHA-MSS) with a valid, strong structure; unique items that provide meaningful information, reliable and interpretable scoring; and practical use as a communication tool between patients and healthcare providers. Secondary objectives were: first, to compare EMHA-MSS with MIDAS and HIT-6 to benchmark it against established metrics; second, to verify test-retest reliability after two weeks; and third, to validate the English version of the EMHA-MSS by comparing results with the

Spanish version. This work has been presented in preliminary form at the 22nd International Headache Congress (10–13 September 2025, São Paulo, Brazil) and published as an abstract.[16]

Methods

Study design and setting

This cross-sectional, descriptive, quantitative study was conducted between June 2024 and March 2025 at Vall d'Hebron University Hospital's Migraine Adaptive Brain Center, with subsequent scientific committee-led multi-site roll-out. The committee included migraine neurologists and EMHA patient representatives. Item development began at a Scientific Committee workshop in Budapest, where three domains were agreed: frequency, treatment response, and pain intensity. These were operationalized using Vall d'Hebron diary registries, and attack intensity was added after pilot review to capture overall attack severity beyond headache pain, including associated non-pain symptoms and the global disabling nature of the attack. The study comprised three phases. First, pilot analysis at the Vall d'Hebron University Hospital's Migraine Adaptive Brain Center (Barcelona, Spain) used diary registries from 319 patients; comparator analyses against HIT-6 and MIDAS used the subset with complete HIT-6/MIDAS available ($n = 280$). These data informed item selection, field validation, scoring cut-offs, and comparative analyses with established tools (i.e., HIT-6 and MIDAS). Second, the finalized four-item EMHA-MSS was administered to a Spanish validation cohort ($N = 504$). Third, cross-language analyses used a separate English-language dataset ($N = 51$) (NIHR-King's Clinical Research Facility, King's College London), allowing assessment of measurement invariance across languages. Test-retest reliability was assessed in a subset of 342 Spanish participants with complete paired responses two weeks later, which were used to assess the temporal stability of the scoring system.

We obtained the participants' consent before administering the questionnaires, which were kept confidential. The Spanish database had already received IRB approval for research purposes. The UK cohort was conducted as a service evaluation and, in line with UK Health Research Authority guidance, did not require approval from a research ethics committee. We report our results in agreement with the STROBE guidelines.

Participants

We included clinic patients at the Vall d'Hebron Migraine Adaptive Brain Center for the pilot study ($N = 319$). A subset of these patients had complete HIT-6 and MIDAS data available ($n = 280$) and were included in comparative analyses. For cross-language validation, we included patients from the NIHR-King's Clinical Research Facility ($N = 51$) and a larger number from Vall d'Hebron's migraine unit ($N = 504$). No exclusion criteria were pre-established.

Instruments

For EMHA-MSS, a committee of migraine experts conducted a literature review of available questionnaires and defined the purpose, target population, and the construct's dimensionality. The questionnaire was drafted in Spanish and English based on expert-defined domains (frequency, intensity, and treatment response), and Vall d'Hebron diary registries informed how these domains could be captured and scored; item i4 was added after pilot review to capture overall attack intensity. Item i3 was intended to capture the intensity of headache pain, whereas item i4 was intended to capture the patient's global perception of the migraine attack, including associated symptoms (nausea, photophobia, phonophobia, aura), functional impairment, and overall disability. This exploratory EMHA-MSS consisting of i1, i2, and i3 used in the pilot study will be named hereafter "legacy 3-item EMHA-MSS". EMHA-MSS consisted of four close-ended items to enable scoring: i1-frequency of migraine, i2-treatment effectiveness, i3-pain intensity, and i4-attack intensity. Items were iteratively refined with key opinion leaders in the field to ensure clarity, relevance, and consistent interpretation across languages (see Supplemental Material).

Items i1 and i2 were scored on a scale of zero to four (from lowest to highest) and items i3 and i4 on a scale of zero to three. The total lowest score was 0, and the highest was 14 (Supplemental Table S1). However, the fourth item i4 was added after the pilot study, and the scoring was different at that time (i1 ranged from 1 to 5, i2 from 0 to 5, and i3 could be 0, 1, 3, or 5). We used the legacy 3-item EMHA-MSS (i1, i2, and i3) to compare it with HIT-6 and MIDAS, and, consequently, its score ranged from 1 to 15. For interpretability and research use, CFA-derived factor scores were transformed to a *T*-score-style metric using the formula: $T\text{-score} = 50 + 10 \times \text{CFA factor score}$.

Two scoring approaches were considered. First, a simple additive raw sum of the four items (range: 0–14) was calculated and ultimately retained as the primary clinical metric due to its ease of interpretation and use in clinical settings. Secondly, a factor-based score was estimated using Confirmatory Factor Analysis (CFA)-derived factor scores and subsequently transformed to a *T*-score metric centered around a mean of 50 using the formula described above. The *T*-score transformation reflects the differential contribution of each item to the latent migraine severity construct and places results on a standardized scale suitable for cross-study comparisons. The raw summed score and

Table 1. European Migraine & Headache Alliance–Migraine Scoring System (EMHA-MSS) categorization into four levels according to the patient's global score.

For healthcare providers			
Level 1 Mild (Score <6)	**Level 2 Moderate** (Score 6–8)	**Level 3 Severe** (Score 9–11)	**Level 4 Very severe** (Score 12–14)
Patients are generally likely to experience low frequency of migraine or symptoms, and if present, medication is largely effective in reducing the associated pain intensity.	Patients are likely to experience mild-to-moderate symptoms at a greater frequency and lower treatment reliability than those of Level 1, with potentially increased pain intensity.	Patients with moderate-severe symptoms who may have either a greater frequency and/or lower reliability of medication than those of Level 2, with potentially greater intensity.	Patients are likely to experience the most severe symptoms at greater frequencies, with little to no acute treatment reliability in reducing symptoms and pain intensity. Consultation with a headache specialist is recommended to optimize management of the condition.
For patients			
You seem to be currently experiencing migraine infrequently, and your pain and other symptoms appear to have mild intensity. It seems that your medication is helping you to manage the episodes properly.	You seem to be experiencing migraine occasionally, with pain and other symptoms ranging from mild to moderate in intensity. Your medication generally helps you manage the episodes.	You seem to be experiencing migraine episodes quite frequently, with pain and other symptoms ranging from moderate to severe intensity. Your medication may not always resolve the episodes.	You seem to be experiencing migraine episodes very frequently, with severe pain and other intense symptoms. The goal would be to improve management to get to Level 1 or 2.

CFA-derived T-score were very highly correlated (Pearson r = 0.981, 95% CI: 0.976–0.986), indicating that the raw score followed the same direction as the standardized T-score. Thus, the raw score is recommended for practical use of the communication tool, while the *T*-score may continue to be used for further statistical analyses and/or other research purposes. Patients were further classified into four severity ranges (derived post hoc in the Spanish validation cohort ($N = 504$), which had a mean of 8 and a standard deviation of 2): (<6: mild; 6–8: moderate; 9–11: severe; >11: very severe) for interpretability (Table 1). As the EMHA-MSS raw total score is an integer score with a constrained range from 0 to 14, these bands were rounded to clinically practical integer cut-offs and should be considered exploratory until externally validated.

We used the Spanish-validated version of the HIT-6 questionnaire.[17] HIT-6 consists of six questions measuring disability, with a lowest score of 36 (no disability) and a highest score of 78 (high disability).[18] The disability was quantified with the following four impact grades based on the participant's score: little-to-no impact (HIT-6 score: 36–49), moderate impact (HIT-6 score: 50–55), substantial impact (HIT-6 score: 56–59), and severe impact (HIT-6 score: 60–78). We also used the Spanish-validated version of the MIDAS questionnaire.[19] The MIDAS consists of five questions measuring disability in days during the past three months; the lowest score is 0 (no disability) and the highest is 92 (high disability). The disability was quantified with the following four impact grades based on the participant's score: grade I (MIDAS score: 0–5), grade II (MIDAS score: 6–10), grade III (MIDAS score: 11–20), and grade IV (MIDAS score: ≥ 21).

Statistical analysis

A Prescient Healthcare Group consulting team conducted data analysis. Categorical data are presented as absolute numbers and percentages and continuous variables as median and range, since normality could not be assumed. Inter-item relationships were explored using polychoric correlations on ordered factors, as recommended for ordinal psychometric data.[20] Structural validity was evaluated using CFA with weighted least square mean and variance-adjusted estimation (WLSMV), treating all EMHA-MSS items as ordered categorical variables.[20] We tested a one-factor model with a freely estimated residual correlation between items i3 (pain intensity) and i4 (attack intensity) to account for conceptual overlap. Model fit was assessed using WLSMV-scaled chi-square, degrees of freedom, P value, the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Residual (SRMR). Standardized factor loadings quantified item contributions. Internal consistency was evaluated using Omega total (Ω), based on the polychoric correlation matrix, because, unlike Cronbach's alpha, it does not assume equal item loadings.

For comparative validity against HIT-6 and MIDAS, our analyses included cross-tabulations of severity categories, Pearson correlations of continuous scores, and regression

models assessing predictors of reclassification between systems. These analyses provided convergent evidence for the construct validity of EMHA-MSS and contextualized its scoring relative to established migraine disability measures.

We assessed temporal stability in the test-retest subsample ($n = 342$) and calculated intraclass correlation coefficients (ICCs) on CFA-derived *T*-scores, using a two-way random-effects ICC model, which is appropriate for test-retest designs in which the same questionnaire is repeated under comparable conditions.[21] Specifically, ICC(2,1) was used to estimate reliability for a single administration and ICC(2,2) to estimate reliability when two administrations are averaged (Supplemental Table S5). Values indicated poor (<0.5), moderate (0.5–0.74), good (0.75–0.9), and excellent (>0.9) reliability. We also assessed longitudinal measurement invariance across test and retest administrations using configural, metric, and scalar models. Invariance was judged using changes in fit indices (ΔCFI $\leq$0.010 and ΔRMSEA $\leq$0.015).

We assessed measurement invariance across Spanish ($N = 504$) and English ($N = 51$) samples using a multigroup CFA. We tested configural (same structure), metric (equal loadings), and scalar (equal thresholds) invariance sequentially. For measurement invariance analyses using WLSMV with categorical data, invariance was judged by changes in CFI, RMSEA, and SRMR. When full scalar invariance was not achieved, we tested partial scalar invariance by freeing specific thresholds suggested by modification indices. In the final partial scalar model, threshold i4|t1 was freed.

All analyses were conducted in R (version 4.5.2) using standard psychometric packages (R Core Team [2025]. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/).

Results

EMHA-MSS against MIDAS and HIT-6

The female-to-male ratio was 83:17 in the pilot study population ($N = 319$), with a median age of 51 years (range: 16–89) (Table 2). Comparative analyses against HIT-6 and MIDAS were performed in the subset with complete paired HIT-6/MIDAS data ($n = 280$). Since the legacy 3-item EMHA-MSS score had a different scoring (range: 1–15), its categories were different from those of the complete EMHA-MSS (compare Supplemental Tables S2 and S3 with Table 1). Most patients remained in a consistent grouping when transitioning from HIT-6 or MIDAS to the legacy 3-item EMHA-MSS. For HIT-6 and the legacy 3-item EMHA-MSS, the highest consistency was observed in the group with the highest scores (99, 66.4%) (Suppl. Table S2). Similarly, the same was true for the MIDAS and the legacy 3-item EMHA-MSS highest scores (106, 61.6%) (Supplemental Table S3).

In HIT-6, a certain number of patients experienced one (77, 27.5%), two (45, 16.1%), or three (23, 8.2%) reclassifications (i.e., shifts by 1–3 severity levels when mapped from HIT-6 grades to the legacy 3-item EMHA-MSS bands). Directionally, increases (to a higher legacy 3-item EMHA-MSS category) totaled 65 and decreases (to a lower legacy 3-item EMHA-MSS category) totaled 80. Correlation analysis showed the strongest association between acute treatment reliability and the magnitude of reclassification ($r = -0.46$), followed by pain intensity ($r = -0.30$), with frequency near the null ($r = -0.04$). This negative association indicates that better acute treatment reliability (lower i2 score, i.e., more effective treatment) was associated with larger reclassifications.

With respect to MIDAS, patients also experienced one (76, 27.1%), two (44, 15.7%), or three (30, 10.7%) reclassifications (i.e., shifts by 1–3 severity levels when mapped from MIDAS grades to the legacy 3-item EMHA-MSS bands). Increases totaled 82 and decreases totaled 68. The strongest association in the correlation analyses was observed between acute treatment reliability and the magnitude of reclassification ($r = -0.46$), followed by pain intensity ($r = -0.33$), with frequency near the null ($r = -0.09$).

EMHA-MSS characteristics

Structure and item analysis. In the validation sample ($N = 504$), model fit was excellent: CFI = 1.000, TLI = 1.000, RMSEA = 0.000, SRMR = 0.003 and WLSMV-scaled chi-square = 0.561 (df = 1, P = 0.454). Factor loadings were 0.660 for i1, 0.635 for i2, 0.561 for i3, and 0.606 for i4, indicating that all items contributed meaningfully to the latent migraine severity construct, with i1 showing the strongest contribution. Internal consistency was excellent (Omega Total (Ω) = 0.81). Polychoric correlations showed moderate correlations for i1 and i2 with other items, and a strong correlation between i3 and i4 (0.925) i.e., patients who reported severe pain also tended to report strong attacks (Figure 1; Supplemental Table S4). Given the conceptual overlap between pain intensity and global attack intensity, model fit was poorer without this residual covariance: WLSMV-scaled chi-square = 80.562 (df = 2, P < 0.001), CFI = 0.996, TLI = 0.987, RMSEA = 0.222, and SRMR = 0.078. The standardized residual correlation between i3 and i4 was 0.89 (95% CI: 0.86–0.92), supporting the decision to model their conceptual overlap while retaining both items.

Reliability and interpretability. *T*-scores were approximately centered at 50 (mean 50.01 and median 49.59), with an observed range of 39.06 to 61.59 and observed SD of 5.53, indicating that the scale captured meaningful variability in migraine severity (Figure 2).

Table 2. Demographic characteristics of study participants.

	Pilot study population[a] ($N = 319$)	Spanish sample[b] ($N = 504$)[c]	Test-retest sample[d] ($n = 342$)[c]	English sample[e] ($N = 51$)
Sex, *No.* (%)				
Female	266 (83.4)	436 (86.5)	299 (87.4)	49 (96.1)
Male	53 (16.6)	62 (12.3)	40 (11.7)	2 (3.9)
Age (years), *median* (range)	51 (16–89)	50 (7–89)	50 (7–89)	44 (18–78)

[a]The pilot study of the legacy 3-item EMHA-MSS was used to benchmark the scoring system against HIT-6 and MIDAS.
[b]The Spanish sample was used to validate the finalized four-item EMHA-MSS.
[c]When conducting the sampling, the sex was not documented for a small number of patients.
[d]This was a subset of the Spanish sample used for the test-retest reliability of the four-item EMHA-MSS.
[e]The English sample was used to measure the invariance across the two languages (Spanish and English)
Abbreviations: EMHA-MSS, European Migraine & Headache Alliance–Migraine scoring system; HIT-6, Headache Impact Test; MIDAS, Migraine Disability Assessment.

Test-retest reliability in the retest sample ($n = 342$) was assessed using ICCs calculated on CFA-derived *T*-scores. Reliability for a single administration was good (ICC[2,1] = 0.868, 95% CI: 0.839–0.892), while reliability based on the average of two administrations was excellent (ICC[2,2] = 0.929, 95% CI: 0.912–0.943) (Supplemental Table S5). The standard error of measurement was 2.05 *T*-score points, and the minimum detectable change at the 95% confidence level was 5.7 *T*-score points.

Longitudinal invariance and score stability

Longitudinal invariance analyses showed that the EMHA-MSS measured the same construct across test and retest administrations. Model fit remained excellent across configural, metric, and scalar models, supporting full scalar invariance over time (Supplemental Table S6). Invariance was evaluated using changes in fit indices (ΔCFI ≤0.010 and ΔRMSEA ≤0.015). In the scalar model, the WLSMV-scaled chi-squared was 7.215 (df = 9, P = 0.615), with CFI = 1.000, TLI = 1.001, RMSEA = 0.000, and SRMR = 0.014.

The mean *T*-score change between retest and test was −0.02 points (95% CI: −0.31 to 0.27, $P = 0.884$), indicating no systematic change between administrations. The *T*-scores remained stable across test and retest administrations, and the observed difference was not statistically significant.

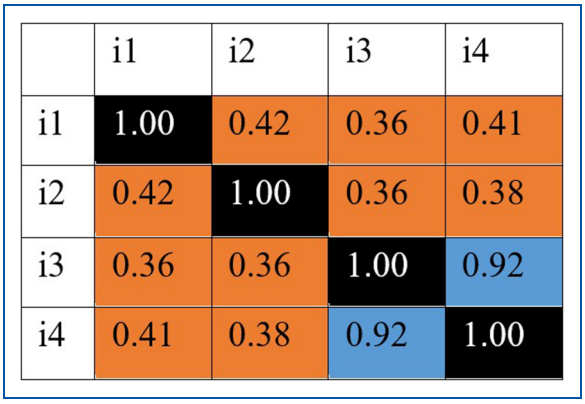

Figure 1. Polychoric correlation matrix of EMHA-MSS items (N = 504). Strong correlations (>0.6) are highlighted in blue, moderate correlations (0.3-0.6) are highlighted in orange, and weak or no correlations (<0.3) are highlighted in white. The strongest correlation was observed between i3 (pain intensity) and i4 (attack intensity), indicating substantial overlap in perceived migraine severity. EMHA-MSS = European Migraine & Headache Alliance - Migraine Scoring System; i1 = item 1-Frequency; i2 = item 2-Treatment effectiveness; i3 = item 3-Pain intensity; i4 = item 4-Attack intensity.

Validation of EMHA-MSS English version

For the Spanish sample (N = 504), the median score was 49.59 (range: 39.06–61.59), while it was higher for the English sample (median: 57.23; range: 39.06–63.78) (Figure 3). Configural and metric invariance showed excellent fit (configural: CFI = 1.000, RMSEA = 0.000, SRMR = 0.006; metric: CFI = 1.000, RMSEA = 0.000, SRMR = 0.015). Complete scalar invariance showed acceptable CFI but worsened RMSEA (CFI = 0.999, RMSEA = 0.050, SRMR = 0.022). After freeing threshold i4|t1, the final partial scalar invariance model showed improved fit (CFI = 1.000, RMSEA = 0.020, SRMR = 0.018), supporting partial scalar invariance.

Discussion

This study showed that the EMHA-MSS is statistically sound as a single-factor scale reflecting migraine severity. In comparisons between the legacy 3-item EMHA-MSS, HIT-6, and MIDAS, acute treatment reliability was the main driver of reclassification, suggesting that patients were more likely to change categories as acute treatment became more effective. The model showed excellent fit,

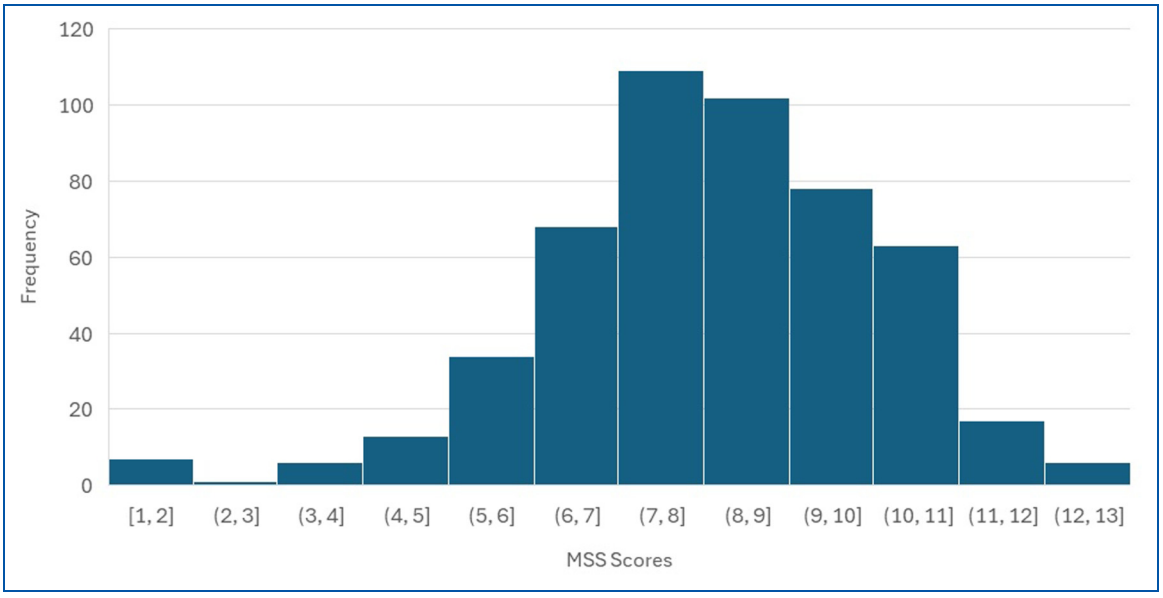

Figure 2. Distribution of EMHA-MSS raw total scores (sum of 4 items) among study participants ($N = 504$). Higher scores indicate greater migraine burden/severity. Level 1, mild (<6); level 2, moderate (6-8); level 3, severe (9-11); level 4, very severe (>11). EMHA-MSS = European Migraine & Headache Alliance - Migraine Scoring System.

supported the expected factorial structure, and enabled reliable factor-score calculation. The T-score showed that the distribution was symmetrical and that our score range captured well the variability in symptom severity. The test-retest reliability was good for single administrations and excellent when two administrations were averaged. The English version showed preliminary cross-language validity: configural and metric invariance were supported, and acceptable partial scalar invariance was achieved after freeing selected thresholds. Since full scalar invariance was not achieved and the English-language sample was smaller, the higher English scores should be interpreted cautiously; they may reflect differences in clinical burden, referral setting, treatment exposure, or sample composition, while residual language- or culture-related measurement effects cannot be fully excluded. The EMHA-MSS is not intended to diagnose, guide treatment decisions, or replace clinical judgment; scores are intended to support patient-clinician communication and shared understanding.

Crosswalk analyses showed high concordance in the most severe categories when mapping HIT-6/MIDAS to the legacy 3-item EMHA-MSS, suggesting strongest agreement among patients with highest severity, consistent with convergent validity between HIT-6, MIDAS, and other migraine patient-reported outcome measures (PROMs) in clinical trials of preventive therapies.[22,23] Reclassification was driven mainly by treatment effectiveness or pain intensity, suggesting that including acute-treatment responsiveness can shift severity bands compared with instruments focused mainly on impairment or lost days. These findings also aligned with evidence that HIT-6 and MIDAS, while robust, primarily emphasize attack-related impairment and recall of lost productivity, respectively, potentially missing aspects of treatment responsiveness. Indeed, HIT-6 emphasizes headache's functional impact, while MIDAS focuses on lost days of school/work, household chores, and leisure time over the past three months. Neither of them explicitly integrates treatment satisfaction or reliability.[24] MIDAS has also been critiqued for limited responsiveness and recall bias, with a minimal important change of 4.5 points but only moderate correlation with patient global change (area under the curve: 0.63–0.68), implying limited sensitivity to detect clinically meaningful change.[10] Thus, the fact that the legacy 3-item EMHA-MSS reclassified some cases beyond HIT-6/MIDAS boundaries may reflect the value of including treatment effectiveness as a discriminating subdomain, especially in the current era of targeted migraine therapies.

The four-item EMHA-MSS demonstrated excellent unidimensional fit, supporting a single latent construct of migraine severity. This is consistent with the design goal of a compact, severity-oriented PROM and aligns with contemporary COSMIN guidance on structural validity for PROMs.[25] Standardized loadings were all positive, indicating that frequency (i1) was the strongest indicator (0.660), while treatment effectiveness (i2) and intensity items (i3 and i4) contributed moderately. Pain intensity and attack intensity were strongly correlated, as expected, but were retained because they represent related but conceptually distinct aspects of migraine burden. EMHA-MSS item loadings, where the frequency item showed the strongest

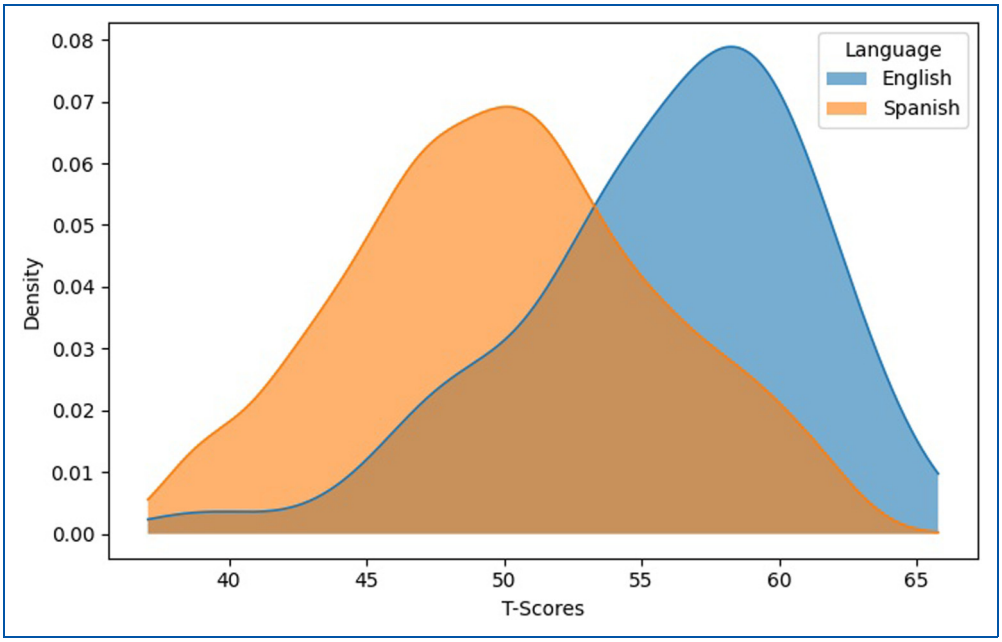

Figure 3. *T*-scores overlap for English ($N = 51$) and Spanish ($N = 504$) participants who completed the European Migraine & Headache Alliance - Migraine Scoring System questionnaire. Mean for English: 55.80 (standard deviation: 5.17), mean for Spanish: 50.01 (standard deviation: 5.53).

contribution, while intensity and treatment-effectiveness captured ancillary but meaningful variance, were plausible in a migraine severity instrument and mirrored patterns observed in other headache PROMs (e.g., HIT-6 content mixes functional and symptomatic impact even under a dominant factor).[22] Internal consistency based on Omega Total supported reliability of the overall scale; Omega Total was excellent. The decision to retain a simple summed score for clinical use, with optional *T*-score transformation for research, followed recommendations to privilege interpretability and feasibility when measurement precision is not materially compromised.[25] The CFA-derived *T*-score is psychometrically preferable for research use because it reflects the differential contribution of each item to the latent migraine severity construct, whereas the raw score remains more practical for routine patient-clinician communication. The banded severity categorization (levels 1 to 4) provided face-valid strata analogous to HIT-6 and MIDAS impact grades.

The short-interval test-retest performance supported the temporal stability expected for a severity scale when no clinical change has occurred. In the Spanish test-retest subsample, CFA-derived *T*-score reliability was good for single administration and excellent when averaging two administrations, consistent with COSMIN expectations for PROM reliability,[25] and supporting the use of the EMHA-MSS total score for longitudinal assessment. By comparison, HIT-6 showed intra-class reliability of 0.77 in its initial validation across episodic and chronic migraine groups.[18] More recently, in the PROMISE-2 study of chronic migraine, the HIT-6 demonstrated reliability and validity (Cronbach's α: 0.82–0.92; test-retest ICC: 0.76–0.80) across trials and across subgroups.[22,26] MIDAS, while widely used, has reported more modestly test-retest data. Original studies estimated Spearman correlations of 0.77 between the three-month total score and daily measures.[11,27] Some migraine disability validations reported reliability coefficients for individual items ranging from 0.54 to 0.71.[28] Of note, since MIDAS spans three months, temporal stability may partly mask responsiveness. Overall, EMHA-MSS test-retest performance was at least comparable to legacy instruments, while longitudinal invariance showed that it consistently measured the same construct over time, supporting its use in follow-up studies and in those evaluating the patient's clinical evolution.

Between-language analyses supported configural and metric invariance (excellent fit) and acceptable partial-scalar invariance after freeing threshold i4|t1, indicating comparable factor structure and loadings across Spanish and English and permitting meaningful comparisons of latent severity. The single threshold that required freeing, i4|t1, lies at the boundary between the two lowest response categories of the attack-intensity item, namely "N/A (no migraine days)" and "mild". This is the sparsest region of the response distribution: in the Spanish validation cohort, the "not applicable" option of i4 was endorsed by very few patients (~2%) and was therefore collapsed into the "mild" category, whereas the corresponding "not applicable" option of the pain-intensity item (i3) was selected by no patient. The wording of these anchors is deliberate and identical in the Spanish

source version: i4 is framed around the global migraine attack (Spanish: "No aplica [No he tenido ataques de migraña]"; English: "N/A [no migraine days]"), whereas i3 is framed around days of headache pain (Spanish: "No aplica [No he tenido días de dolor de cabeza]"; English: "N/A [no headache days]"), consistent with their distinct constructs. Because the prevalence of this lowest "no migraine days" category is low and sample-dependent, the threshold separating it from "mild" is precisely where minor cross-language non-equivalence would be expected; freeing i4|t1 therefore reflects this structural, low-prevalence difference at the floor of the scale rather than a substantive difference in how migraine severity is measured across languages. This pattern followed the recommended practice in multi-group CFA for PROMs, where partial-scalar solutions are commonly acceptable for cross-language comparisons when fit decrements indicate threshold non-equivalence on a subset of items.[29] Taken together with the longitudinal invariance observed across test and retest administrations, where full configural, metric, and scalar invariance was supported over time (Supplemental Table S6), these analyses indicate that the EMHA-MSS measures the same underlying construct both across repeated administrations and across the Spanish and English versions. Therefore, given the supported metric invariance and acceptable partial scalar invariance, group differences can be interpreted at the construct level.[29] The higher scores observed in the English-language sample may reflect differences in clinical burden, treatment exposure, referral setting, or other sample characteristics. Since the English-language sample was smaller and scalar invariance was partial rather than full, these between-sample differences should be interpreted as preliminary. The translation workflow (forward-back translation with expert reconciliation) aligned with international recommendations for translation and cultural adaptation of PROMs, strengthening content equivalence claims across languages.[30]

Our psychometric and comparative findings were derived primarily from specialized headache centers in Spain (pilot/validation) and a smaller UK cohort, which supports internal validity. Additionally, the observed patterns paralleled those seen with legacy instruments across diverse settings-including the robust reliability/validity of HIT-6 in chronic migraine,[22] suggesting that EMHA-MSS captured clinically salient variance likely to translate beyond a single health system. Notably, the EMHA-MSS was initially developed in collaboration with patients, contrary to other available PROMs in the field (e.g., HIT-6 and MIDAS). This patient-informed development process is a strength of the tool, because the EMHA-MSS was designed not only as a psychometric measure but also as a practical communication aid for patients and clinicians. Planned and ongoing translations (Greek, Danish, Dutch, Portuguese, German, French) should follow established cross-cultural adaptation and measurement-invariance testing procedures (configural → metric → scalar), ideally against COSMIN reporting standards to maximize transportability and uptake in multinational clinical research.[25,30]

Our study was limited mainly by its self-reported design, use of only the available Spanish and English versions, and convenience sampling rather than a population-based frame, which may have limited its external validity. Participants who opt into surveys about migraine may differ systematically (e.g., severity, treatment engagement) from the broader migraine population. Since the severity categories were derived from the post-hoc analysis of the validation cohort originating from a specialty institution, patients with more severe migraine might have been overrepresented. These categories should be treated as exploratory until confirmed. Detailed clinical descriptors, including migraine duration, subtype, medication class, and prior treatment exposure, were not systematically collected. Although initial item development was informed by migraine diary registries, final validation focused on EMHA-MSS item responses and available demographic variables. Future studies should include more detailed clinical phenotyping to evaluate how scores vary by disease duration, subtype, and treatment history. Test-retest reliability was assessed within a two-week interval without a stability anchor, so variation may reflect true changes in migraine burden rather than measurement variability. Cross-language analysis was limited by the smaller English sample and by achievement of partial, rather than full, scalar invariance; language-group differences should be considered preliminary until replicated in larger cohorts. Finally, some indicators required recall over a month, introducing potential recall and reporting bias.

Conclusion

This new scoring system highlighted the importance of treatment reliability, pain intensity, and frequency in categorizing patients into a simple migraine severity grouping. The EMHA-MSS could facilitate tailored management and longitudinal monitoring, potentially improving alignment with sufferers' perceptions and enhancing patient-physician communication and understanding. The EMHA-MSS partially aligned with established metrics while introducing a new way of evaluating migraine severity. Further prospects include translating and validating the novel scoring system into additional languages and undertaking larger-scale studies to confirm or refine our findings.

Clinical implications

- The EMHA-MSS is a novel scale to evaluate the severity of migraine reported by patients.
- This new scoring system classifies patients with migraine based on the frequency of migraine, treatment effectiveness, pain intensity, and attack intensity.
- The scores obtained in the EMHA-MSS may be used to foster patient-clinician conversations and shared understanding.

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Ethical considerations

The Spanish database had already received IRB approval for research purposes. The UK cohort was conducted as a service evaluation and, in line with UK Health Research Authority guidance, did not require approval from a research ethics committee.

Consent to participate

Not applicable.

Consent for publishing

On behalf of all co-authors, I confirm that all authors have reviewed and approved the final version of the manuscript and consent to its publication in Cephalalgia.

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Disclosure statement

All other authors declare no conflict of interest with the present study.

Data availability statement

The data underlying this article will be shared upon reasonable request to the corresponding author.

Open practices

Not applicable.

Supplemental material

Supplemental material for this article is available online.

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