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Multidimensional Subgroups in Migraine: Differential Treatment Outcome to a Pain Medicine Program

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ABSTRACT

Objective. The present study compared two different approaches for deriving patient profiles on their ability to predict treatment outcome to a pain medicine program for migraine headache.

Design/Methods. Using visual analog scale measures of pain intensity and functional limitations and the Beck Depression Inventory (BDI), as a measure of depression, 235 migraine patients were classified into statistical clusters. The same patients were also classified using the Multidimensional Pain Inventory (MPI) algorithm into three subgroups: Adaptive copers (AC), characterized by lower reported levels of pain intensity, life interference, and distress, as well as higher levels of perceived life control; interpersonally distressed (ID), characterized by more intermediate levels of pain, distress, and interference, with a predominant perception of inadequate support and punishing responses from significant others; and dysfunctional (Dys), characterized by high levels of pain severity, life interference, and distress and low levels of perceived life control and activity.

Results. The results of the K-cluster analysis yielded a three-cluster solution: The low impact cluster, was characterized by low pain, low functional limitations and low depression and showed significant reductions in pre-to-posttreatment pain; the moderate impact cluster displayed higher levels of pain and functional limitations and low depression and showed only slight pre-to-posttreatment pain reduction; and the high impact cluster displayed the highest levels of pain, functional limitations, and depression and showed significant increases in pre-to-posttreatment pain. Unlike the K-clustered groups, MPI subgroups failed to differentially predict treatment outcome. When the K-clustered groups were crosstabulated with the MPI subgroups, the predictive validity of the MPI subgroups was enhanced.

Conclusion. This study questions the validity of the MPI subgroup classification algorithm. The results indicate that the K-clustering approach is more useful than the MPI in deriving meaningful patient clusters that differentially predict treatment outcome in a migraine population.

Key Words. Migraine; Psychological Subgroups; MPI (Multidimensional Pain Inventory); Cluster Analysis; Treatment Outcome

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Introduction

There are a variety of strategies in the pain literature for grouping chronic pain patients based on psychological and behavioral measures [1]. Ideally, grouping or profiling should have utility for classifying individual patients into distinct and clinically meaningful groups, determining differential treatment strategies, and predicting treatment outcomes [2,3].

It is accepted that individuals with persistent pain often present with a constellation of symptoms that includes high pain intensity, health-related impairment, and dysphoric mood [4–6]. Klapow et al. [7] used a cluster analysis to profile chronic low back pain (CLBP) patients using separate, well-validated instruments to measure each of these dimensions. They used the Beck Depression Inventory (BDI) [8] as a measure of dysphoric mood and the McGill Pain Questionnaire (MPQ) [9] Pain Rating Index (PRI) to assess pain severity, and health-related impairment was measured using the Sickness Impact Profile (SIP) [10]. The results of their analysis yielded three distinct profiles: The good pain control (GPC) group, showing low levels of pain, impairment, and depression, the positive adaptation to pain (PAP) group, showing high levels of pain and low levels of impairment and depression, and the chronic pain syndrome (CPS) group, displaying high levels of pain, impairment, and depression. The constructs were shown to be stable across a 6-month period. In a sequel to that study, Klapow et al. [11] showed that patients in the CPS group were more likely to experience high levels of life adversity, passive coping with pain exacerbations, and lower satisfaction with social support when compared with the GPC and PAP groups. In contrast, patients in the GPC group tended to report low levels of life adversity, active coping, and higher satisfaction with social support, while members of the PAP group reported lower levels of life adversity and higher satisfaction with social support, but passive coping with pain exacerbations. To date, there are no data examining the utility of these constructs in predicting treatment outcome.

By contrast, the West Haven-Yale Multidimensional Pain Inventory (MPI) [12–14] is one of the most widely used multidimensional instruments to measure adaptation to pain. Proponents of the MPI state that it is a comprehensive measure of psychological and emotional functioning in chronic pain, and it has been touted to be one of the best instruments available for assessing overall adjustment of chronic pain patients [15]. The MPI is a self-administered questionnaire comprising 12 empirically derived scales that measure dimensions of pain perception, life interference due to pain, perception of life control, affective distress, and social support. The instrument uses a clustering approach to derive three distinct subgroups: Dysfunctional (Dys), interpersonally distressed (ID), and adaptive copers (AC). The Dys subgroup is characterized by high levels of pain severity, life interference, and distress and low levels of perceived life control and activity. Dys patients are hypothesized to be the most disturbed and least amenable to treatment [16]. The ID subgroup is characterized by more intermediate levels of pain, distress, and interference, with a predominant perception of inadequate support and punishing responses from significant others. The AC subgroup is characterized by lower levels of reported pain intensity, life interference, and distress, as well as higher levels of perceived life control [17]. AC patients are described as more emotionally healthy, remaining active despite pain, feeling little psychological distress or life interference, having a sense of control of their lives in the presence of pain [16], and purportedly not in need of psychological intervention [18].

The MPI classification algorithm uses a goodness of fit decision rule to determine whether an individual's set of MPI standardized scale scores is similar to that of a prototypic profile in order to be assigned to one of the three clinical subgroups: AC, ID, or Dys. Test results that do not fall clearly into one of the profiles or that contain missing scale values are considered invalid for meaningful clinical interpretation. This classification algorithm was developed to provide clinical descriptors of patients based on the MPI scales that can be generalized across chronic pain populations and specific diagnoses.

Using a migraine population, the present study sought to replicate and extend the Klapow et al. [7] categorization using parallel measures of pain, depression, and pain limitation in a cluster analysis. As in Klapow et al. [7], the BDI was used as a measure of dysphoric mood. Two visual analog scales (VAS) were used to measure pain limitation and pain intensity. The latter two measures conceptually paralleled the SIP and MPQ-PRI, respectively, used by Klapow et al. [7], but were much simpler to administer. We then compared the relative efficacies of the derived clusters and the MPI subgroups in predicting treatment outcome to a pain medicine migraine headache program.

Methods

Participants

Two hundred and thirty-five consecutive patients diagnosed with migraine headache that were

referred to the Pain Center at Cedars-Sinai Medical Center served as participants in the study. The main criterion for inclusion was a diagnosis of migraine adhering to the International Headache Society classification criteria [19] made by a headache specialist. Inclusionary criteria also included completion of the requisite instruments, pain of at least 6 months duration, completeness of medical records, and no comorbid medical conditions. The mean duration of pain was 146 months. Eighty percent (N = 186) of the participants were women. Their ages ranged from 16 to 87, with a mean of 45 years. The mean number of specialists seen for the presenting complaint prior to referral to the Pain Center was four.

Instruments

Beck Depression Inventory

The BDI was administered pretreatment. The BDI is a well-validated, widely used screening instrument to measure the cognitive/affective and neurovegetative symptoms of depression. It is a brief 21-item paper-and-pencil self-report. Based on a summative score, depression is assessed as: 0–9, minimal depression; 10–18, mild to moderate depression; 19–29, moderate to severe symptoms; or 30–63, severe depression. The BDI has excellent reliability and validity [8].

Visual Analog Scale–Pain Intensity

Participants were asked to retrospectively rate their usual (VAS–Usual), high (VAS–High), and low (VAS–Low) pain intensities over the past week using separate horizontally placed 100-mm VASs. "No pain" anchored the VAS on the left, and "The most intense pain imaginable" anchored the right. Participants placed a mark on the VAS to indicate their pain intensity. The reliability and validity of the VAS as a ratio-level scale is well established [20]. Participants rated their pain pretreatment, posttreatment, and at follow-up.

Visual Analog Scale–Pain Limitation

Participants were asked to rate the following: "How much has your pain interfered with your activities over the past week?" using a VAS for functional limitations (VAS–L). The VAS–L was anchored on the left by "None" and on the right by "Complete."

Multidimensional Pain Inventory

The MPI was administered pretreatment. It is a 61-item self-administered questionnaire composed of 12 empirically derived scales designed to measure a patients' experiences of pain, their spouses responses to their pain, and their general activity levels [12,21].

Procedure

After their initial consultation with the headache and orofacial pain medicine physician, participants were administered the instruments. Once the instruments were completed, they became part of the patients' medical records. The participant then underwent a 1-hour behavioral medicine evaluation with a health psychologist. Treatment typically consisted of a program 5–9 weeks in duration, where the patient saw the pain medicine physician and health psychologist on a weekly basis on the same day each week. Participants were withdrawn from all analgesics and trialed on an array of triptans, beta-blockers, and antiseizure medications based on their ability to tolerate them. The median number of visits with the pain medicine physician was seven. The behavioral medicine treatment consisted of three to six standardized sessions of brief relaxation training, biofeedback (digital skin temperature feedback), and brief cognitive interventions targeting the patient's primary maladaptive pain-related coping strategies. The median number of behavioral sessions was four.

Data Analysis

To derive the cluster subgroups, cluster analysis was performed on the pretreatment measures of VAS–Usual, VAS–L, and the BDI for all 235 participants. These measures were chosen because they paralleled those used by Klapow et al. [7]. The SPSS Version 8.0 statistical package was used for all analyses (SPSS Inc., Chicago, IL).

The same 235 patients were also classified based on their MPI results, using the scoring and classification program developed by Rudy et al. [21], into the Dys, ID, and AC subgroups. This program uses decision rules based on an initial clustering analysis [17] to place individuals into the group whose prototypical profile of scales most closely matches their scale values and has been widely used in a variety of pain populations. If a profile is significantly different from all three of the prototypic subgroup profiles, the profile is deemed "anomalous." If the profile is similar to one of the three patterns but not a close enough match, the algorithm classifies the person as "hybrid." If the profile is incomplete due to missing scales (as happens if the subject does not have a spouse), the profile is deemed "unanalyzable" [21]. The anomalous, hybrid, and unanalyzable profiles were considered to render no valid clinical information and were not used in any subsequent analyses in this study.

The MPI subgroups and our K-clustered subgroups were tested for differences in age, gender, and pain chronicity and the pretreatment

VAS–Usual, VAS–L, and BDI measures using analysis of variance (ANOVA) or Chi-Square tests. The effect of subgroup membership on treatment outcome was also analyzed by ANOVA. Pretreatment VAS scores were obtained on the initial evaluation session prior to any treatment, and posttreatment scores were obtained on the final discharge treatment session. Outcome was determined by computing percent changes pre-to-posttreatment for the VAS–Usual, VAS–High, and VAS–Low pain intensity measures, as follows: (pretreatment VAS score—posttreatment VAS score)/ pretreatment VAS score. Percent change has been shown to be a more sensitive measure of pain relief than other outcome measures [22].

Groups derived from the K-means analysis were then crosstabulated and compared with the MPI subgroups. The crosstabulated groups were compared on treatment outcome using ANOVA and Bonferroni post hoc comparisons.

Results

K-clustered Groups

Clustering pretreatment measures of VAS–Usual, VAS–L, and the BDI rendered a three-group solution that provided the most discrete clusters. Of the 235 participants, 199 were classified. The loss of sample size was due to missing data; however, all patients with complete data were classified. Examination of other cluster solutions (e.g., those with two and four clusters) did not improve the distinctness of groups. Similar to the study by Klapow et al. [7], the largest increase in variance was found in the transition from a three-cluster solution to a two-cluster solution, indicating that the three-cluster solution contained the most homogeneous groups. To improve the homogeneity of the initial cluster assignments, a K-means iterative portioning procedure was applied to the three-cluster solution. This method compares individuals from each cluster and relocates any misassigned individual to a more appropriate cluster. The result is a decrease in within-cluster variance and an increase in between-cluster variance, thereby sharpening the solution [7]. The derived profiles are similar to those described by Klapow et al. [7] and are depicted in Table 1A. The first cluster was named low impact and showed lower usual pain, lower pain limitation, and lower depression (N = 117); the second cluster, moderate impact, displayed moderate usual pain, moderate pain limitation, and lower depression (N = 49). The third cluster, high impact, was characterized by high usual pain, high pain limitation, and higher depression (N = 33). One way ANOVAs showed no significant differences among the K-clustered groups in age or pain chronicity. Chi-square analysis showed no significant gender differences. Significant differences were observed in the pretreatment measures of VAS–L, $F(2,185) = 15.394$ ($P < 0.0001$), and VAS–Usual, $F(2,185) = 14.008$ ($P < 0.0001$). The high impact group scored higher on VAS–Usual, VAS–L, and the BDI (Table 1A). As depicted in Table 2A, the high impact group also showed the poorest outcome when compared with the other groups, with pain levels actually increasing from pretreatment to posttreatment. ANOVA showed a reliable Groups main effect on treatment outcome for the percent changes in the VAS–Usual,

Table 1 Pretreatment means (standard deviations) of VAS pain intensity measures and BDI scores for K-clustered groups and MPI subgroups

A) K-clustered groups

	Low impact	Moderate impact	High impact
BDI	13.2 (8.6)	14.1 (10.5)	17.0 (9.5)
VAS–Usual*	44.9 (21.4)	51.8 (20.4)	68.1 (22.7)
VAS–L*	49.5 (30.3)	63.9 (24.1)	79.9 (22.9)

B) MPI subgroups

	AC	ID	Dys
BDI†	8.9 (6.1)	16 (9.7)	18.0 (8.9)
VAS–Usual†	48.4 (19.9)	68.9 (23.1)	76.5 (22.8)
VAS–L†	42.2 (19.9)	56.5 (14.0)	63 (18.0)

* High, low, and moderate impact groups were significantly different from each other at $P < 0.05$.
† AC, Dys, and ID subgroups were significantly different from each other at $P < 0.05$.

Table 2 Pre-to-posttreatment mean (standard deviation) percent changes in VAS scores*

A) K-clustered groups

	VAS–Low†	VAS–Usual†	VAS–High†
Low impact	–51.9 (50.0)	–59.8 (37.6)	–46.9 (35.9)
Moderate impact	–31.1 (59.9)	–16.9 (37.9)	–7.3 (29.0)
High impact	–4.8 (52.6)	+7.7 (25.3)	+5.0 (17.8)

B) MPI Subgroups

	VAS–Low	VAS–Usual	VAS–High
AC	–34.5 (55.3)	–35.7 (47.0)	–24.6 (42.2)
ID	–42.6 (56.8)	–37.6 (39.8)	–31.4 (36.9)
Dys	–31.7 (54.5)	–30.3 (41.6)	–22.9 (39.2)

* – indicates a decrease in pain intensity; + indicates an increase in pain intensity.
† The low impact, moderate impact, and high impact groups were significantly different from each other ($P < 0.03$).

$F(2,117) = 32.28$ ($P < 0.0001$), VAS–High, $F(2,117) = 33.03$ ($P < 0.0001$), and VAS–Low, $F(2,117) = 8.76$ ($P < 0.0001$), pain intensity measures. Post hoc comparisons showed all groups to reliably differ from each other.

MPI Subgroups

Of the total of 235 patients, 85 (36%) were unable to be classified into valid MPI subgroups (AC, ID, Dys). Thirty-four patients had an incomplete MPI, omitting items concerning responses of others to their pain behaviors due to the lack of a spouse. Others with complete profiles who did not fit the scaling requirements were excluded and were, thus, deemed unanalyzable. Of those, 35 (15%) were classified as anomalous, because their response patterns precluded assignment of a posterior probability of inclusion based on Chi-square analysis. Another 16 (7%) did not meet the critical probability for inclusion into one of the valid subgroups according to the algorithm, and were classified as hybrid. This substantial loss of data is much larger than that reported in the original study [21]. Thus, only 150 valid profiles from the original 235 were classified into the three MPI subgroups. Twenty-nine (19.3%) were assigned to the Dys subgroup, 43 (28.7%) were assigned to the ID subgroup, and 78 (52%) were assigned to the AC subgroup.

There were no significant pretreatment differences among the AC, Dys, and ID subgroups in age, gender, and pain chronicity. There were differences among subgroups in the pretreatment measures of VAS–L, $F(2,138) = 15.817$ ($P < 0.0001$), VAS–Usual, $F(2,137) = 14.772$ ($P < 0.0001$), and the BDI, $F(2,142) = 20.78$ ($P < 0.0001$) (Table 1B). In contrast to the K-clustered groups, no significant differences in pain outcome were found based on MPI subgroup membership (Table 2B).

Comparison of Crosstabulated MPI and K-Clustered Groups

In order to better understand the difference in the prediction of treatment outcome for the two classification systems, we crosstabulated membership for the K-clustered groups with the MPI subgroups. This is shown in Table 3. Chi-square analysis revealed that there was not a significant difference between the frequencies of participants with and without complete MPI profiles within the K-clustered groups. Examination of Table 3 shows some consistency for the two systems, but also considerable heterogeneity within MPI subgroups in terms of categorization by the K-means approach. For example, over 70% (N = 45) of the MPI AC subgroup was appropriately classified as low impact, the most positive responders to treatment. However, this left almost 30% the AC subgroup classified as moderate impact or severe impact. The classification of a substantial number of AC patients into the high impact group was unexpected, since a low pain level is a hallmark of the AC subgroup [12], and this may be evidence of misclassification by the MPI algorithm. Statistical analysis of this table was not performed due to the small expected values in some cells.

Table 3 Crosstabulation of the number (percentage) of participants in each of the MPI subgroups falling into the low, moderate, and high impact clusters

	MPI Subgroups		
	AC	ID	Dys
Low impact	45 (70%)	19 (51%)	12 (48%)
Moderate impact	15 (23%)	12 (32%)	6 (24%)
High impact	4 (7%)	6 (17%)	7 (28%)
Total	64 (100%)	37 (100%)	25 (100%)

AC = adaptive copers; ID = interpersonally distressed; Dys = dysfunctional.

In order to statistically examine the effects of the two grouping systems on treatment outcome, we compared the mean percent changes in low, usual and high pain intensity measures for the MPI subgroups crosstabulated with the K-means clusters. Since the crosstabulations of all subgroups led to some cells having numbers too small for meaningful statistical analyses, we combined patients classified into the high impact and moderate impact (both groups having significant pain and limitations) groups for statistical comparison. This led to six combined groups (i.e., AC, ID, and Dys classified as either low impact or moderate/high impact combined), as shown in Table 4. A one-way ANOVA for each of the outcome variables was performed to test for differences among the six combined classification groups. Significant group differences were found for the VAS–High, $F(5,120) = 15.4$ ($P < 0.0001$), and VAS–Usual, $F(5,120) = 15.3$ ($P < 0.0001$), pain intensity scores. More importantly, post hoc tests indicated that, for all three MPI subgroups, there were significant differences in the percent changes of the VAS–High and VAS–Usual pain intensity scores between patients classified as high/moderate impact and those classified as low impact (all $P < 0.005$). For all three MPI subgroups, a worse outcome was found for patients classified as high/moderate impact compared with those classified as low impact (Table 4).

Table 4 Combined group outcomes—mean (standard deviation) percent pre-to-posttreatment change scores for VAS–Low, VAS–Usual, and VAS–High pain intensity measures

	AC (adaptive copers)			Dys (dysfunctional)			ID (interpersonally distressed)		
	Low	Usual	High	Low	Usual	High	Low	Usual	High
Low impact	–47.23 (56.16)	–58.44 (35.03)	–42.62 (34.53)	–54.61 (45.97)	–55.42 (36.50)	–50.74 (38.94)	–60.71 (50.54)	–64.24 (35.24)	–57.52 (35.36)
	N = 45			N = 12			N = 19		
Moderate impact + high impact	–12.73 (66.6)	4.7 (33.5)	6.47 (35.7)	–16.11 (60.2)	–9.41 (38.0)	1.63 (21.4)	–28.10 (61.7)	–19.0 (27.9)	–8.79 (16.0)
	N = 19			N = 13			N = 18		

Discussion

Using a migraine population and relatively simple VAS measures of pain intensity and pain limitations and the BDI to assess dysphoric mood/depression, we describe a three-cluster solution paralleling that described by Klapow et al. [7] in CLBP patients. The first group, termed low impact, showed low usual pain, low pain limitations, and lower depression and demonstrated the most significant pre-to-posttreatment reductions in pain. The second group, moderate impact, was characterized by moderate pain and moderate pain limitations and low depression. This group showed limited pain reduction with treatment. The third group, termed high impact, was characterized by high pain ratings, pain limitations, and dysphoric mood. This represented the most dysfunctional group showing increased high and usual pain intensity levels from pretreatment to posttreatment. These findings further extend those of Klapow et al. [7], by demonstrating differential treatment outcomes based on cluster membership in a migraine population.

Unlike the K-cluster-derived groups in the present study, the MPI subgroups failed to show differential treatment outcomes. Table 2B depicts the modest improvements resulting from treatment in all three MPI subgroups. These data differ from those from two studies showing that MPI subgroups were related to various dimensions of treatment outcome. In the first study, by Rudy et al. [16], 145 patients with temporomandibular disorder underwent splint therapy coupled with stress management and masseter electromagnetic biofeedback. The MPI subgroups in that study all showed similar and significant improvements in physical measures of muscle and temporomandibular joint palpitation pain, unassisted mandibular and maximal mandibular openings, medication use, and health care utilization. However, the Dys subgroup showed a greater improvement on measures of perceived pain impact (MPI-Life Interference from Pain scale), depression (BDI) and catastrophic thinking (CSQ-C) when compared with the ID and AC subgroups, which did not differ from each other on these measures. The AC subgroup showed the least pain reduction as measured by the MPQ-PRI. The authors of that study speculated that this finding likely reflected the AC subgroup's low pretreatment pain levels. The second study by Turk et al. [23] investigated treatment responses among MPI subgroups in 48 patients with fibromyalgia undergoing a 7-week multidisciplinary fibromyalgia program consisting of medical interventions, occupational therapy, physical therapy, and psychosocial interventions. Based on MPI subgroup membership, their results showed wide variability in treatment responses. They found statistically significant reductions in pain, affective distress, perceived disability, and perceived interference of pain in the Dys subgroup. The ID subgroup showed poor treatment responses across all variables measured, while the AC subgroup showed reliable pain reductions only.

The differences between the present study and those of Rudy et al. [16] and Turk et al. [23] may reflect the populations studied, measures of treatment outcome used, and statistical methodology employed. Unlike the VAS pain intensity measures used in the present study, the MPQ-PRI score and MPI PS measures used by Rudy et al. [16] and Turk et al. [23] combine ratings of pain intensity with measures of affect and cognitive appraisal. Thus, it might be argued that the measures are assessing different dimensions of the pain experience. Finally, unlike the previous two studies, we

used percent change as our outcome measure. Farrar et al. [22] give evidence that percent change is more representative of the psychological distance represented by quantitative changes in self-reports of pain than in other measures of treatment outcome. In contrast, Rudy et al. [16] used the reliability of change index and Turk et al. [23] used pre-to-posttreatment difference measures in a repeated measures design.

We also sought to crosscompare membership of our derived factors with those of the MPI. Table 3 depicts this crosscomparison. What is most striking is that the MPI AC subgroup comprised not only, as one would expect, members of the low impact group (N = 45), who are characterized by low pain, depression, and functional limitations, but also patients representing the high impact and moderate impact groups (N = 4 and N = 15, respectively). The high impact and moderate impact groups were characterized by higher pain levels, pain limitations, and dysphoric mood and consistently showed poor treatment responses. Thus, the assumption that the AC subgroup is a homogeneous group of healthy adaptive patients not in need of psychological interventions [18] is not supported. As a result, we question the validity of the MPI AC subgroup classification, at least in this migraine population. Examination of Table 3 also reveals the heterogeneity of the Dys and ID subgroups.

The relationship between the MPI classifications and the treatment response was further evaluated by combining our cluster-derived groups with the MPI subgroups (Table 4). The AC/low impact-combined group showed the greatest pain reductions in the usual, low, and high pain intensity measures compared with the AC/high impact + moderate impact combination, which showed *increased* pre-to-posttreatment pain for the usual, low, and high pain intensity measures. This finding again challenges the validity of the AC subgroup classification and shows that AC is, in fact, a heterogeneous classification consisting of both healthy adaptive copers and those with dysfunctional resources. Turk and Rudy [17], in their initial description of the instrument, speculated that the AC subgroup might comprise "true adaptive copers" and "minimizers." Minimizers are patients who, for whatever reason, are attenuating their response to the test and, therefore, mistakenly appear to have adaptive coping resources. Perhaps it is time to revisit this concept in a more systematic way in order to improve the validity of the AC classification and to provide a more thorough discriminating system, especially given the widespread use of the MPI. The same pattern of responding was also found in the Dys and ID subgroups, also questioning their validity. That is, the Dys/low impact and the ID/low impact groups showed significantly better treatment outcomes than did their respective high/moderate impact counterparts.

Several other investigators have also questioned the MPI subgrouping algorithm as well as the MPI scales upon which it is based. Robinson et al. [24] showed that instruments such as the MPI can be easily manipulated, yielding questionable results. Bruehl et al. [25] expressed concerns about the validity of the MPI and developed a variable responding scale to detect random responding. Deisinger et al. [26] and Riley et al. [27] were unable to duplicate the MPI factor structure. Cleary, more research needs to be done to evaluate and improve the psychometric strength of the MPI and its subgroup classification.

Finally, the K-means approach failed to classify only 36 individuals (18%) from our sample, thus losing much less data than the MPI classification algorithm that failed to classify 85 (36%) of the participants. The MPI rate of misclassification, primarily due to a lack of a spouse, required for the goodness of fit algorithm, has proven problematic in other studies and has prompted a recently revised version, the MPI-M [28].

In summary, this study is the first to show that empirically derived clusters based on measures of pain intensity, pain limitations, and dysphoric mood can predict outcome to migraine treatment. This study further supports the hypothesis that pain intensity, pain limitations, and dysphoric mood form a critical triad in the experience of migraine pain similar to that seen in other pain conditions [2,7,11,29]. It is our opinion that any comprehensive clinical assessment of the pain patient should, at the minimum, include validated measures of pain intensity, pain limitations, and mood/affective distress. Finally, the data suggest that, even for a problem with well-developed pharmacological and behavioral treatments, such as migraine [30], individual patient characteristics must be considered in order to yield optimal clinical outcomes.

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