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[Original article]

Prediction of the prognosis of somatoform disorders using the Minnesota Multiphasic Personality Inventory

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Abstract

Background : Somatoform disorders are frequently resistant to treatment. This study aimed to determine the utility of the Minnesota Multifaceted Personality Inventory (MMPI) in predicting the prognosis of somatoform disorders.

Methods : Overall, 125 patients diagnosed with somatoform disorders between January 1, 2013 and December 31, 2017 in the psychiatric department of Fukushima Medical University Hospital were included. Patients with positive outcomes were identified based on a subjective estimation regarding (1) pain and (2) social functions, including activities of daily living. They were divided into the improved group (IG) and the non-improved group (NIG). Each factor was then descriptively compared between the two groups, and the sensitivity and specificity were determined.

Results : The NIG had significantly higher scores but only on the Hy scale. Thus, the optimal Hy scale cutoff score was calculated. The cutoff point was 73.5, with a sensitivity of 55.7% and a specificity of 71.7%.

Conclusion : An MMPI Hy scale score higher than a cutoff value of 73.5 predicts a poor response to conventional supportive psychotherapy or drug therapy in patients with somatoform disorders. This cutoff point may be used as an important index for selecting treatment for somatoform disorders.

Key words : Consultation-liaison psychiatry, Minnesota Multifaceted Personality Inventory (MMPI), Prognostic predictor, Somatoform disorders, Treatment-resistant

Background

Somatoform disorders are classified as neurotic disorders according to the 10th revision of the International Classification of Diseases (ICD-10)[1)] and the Diagnostic and Statistical Manual of Mental Disorders, fourth edition, text revision (DSM-IV-TR)[2,3)]. Chronic pain is classified into nociceptive, neuropathic, and psychogenic pain[4)]. Among these types, psychogenic pain is classified as persistent somatoform pain disorder in the ICD-10 and chronic pain disorder in the DSM-IV-TR[5)]. In addition to the distress of experiencing the symptoms themselves, chronic pain is likely to cause secondary psychiatric disorders and a decreased ability to carry out activities of daily living (ADLs). Therefore, this disorder cannot be overlooked, especially as it can become a burden for health systems and the

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population at large[6].

Pharmacotherapy in the form of selective serotonin reuptake inhibitors, antipsychotic drugs, and benzodiazepine anxiolytics are useful to some extent for somatoform disorders[7], however no effective treatment has been established. While research on the neural basis of these disorders is currently in progress, recovery from somatoform disorders is often difficult and largely dependent on psychosocial treatment[8].

Since 1996, as part of consultation-liaison psychiatry services, conferences which consist of teams that include orthopedists, psychiatrists, nurses, physical therapists, psychologists, pharmacists, and social workers, have been conducted at Fukushima Medical University Hospital (FMUH). These conferences are held once a month and involve discussions on how to manage the psychosomatic problems of patients with somatoform disorders. Owing to these conferences, we have accumulated substantial Minnesota Multifaceted Personality Inventory (MMPI) data for these cases. Many patients with psychosocial personality problems or psychiatric disorders have a history of consultation with an orthopedist because of chronic pain and numbness or have not been satisfied with conventional orthopedic treatment[5,9].

The multidisciplinary nature of these conferences is based on recognition of the role that "team medical care" has in promoting effective treatment and solving various problems. Specifically, a psychiatrist reviews patients who are identified at these meetings as having psychiatric problems, like a somatoform disorder. In addition, the orthopedist remains involved in treatment because even if the patient has psychiatric, psychological, or social problems, the chief complaint is a physical symptom[5,9].

Numerous studies have reported personality tendencies in patients with somatoform disorders based on the MMPI[10-18]. However, to the best of our knowledge, no studies have assessed the utility of the MMPI in predicting the prognosis of somatoform disorders, and only a few studies have used it to predict outcomes of surgical treatment for chronic back pain[19-22]. We hypothesized that the accumulated MMPI data on the aforementioned cases could be used for the purpose of evaluating whether patients with chronic pain have latent paranoia, depression, or other psychiatric disorders, as well as whether their personalities affect their symptoms[23,24].

Using MMPI for predicting the prognosis of somatoform disorders, treatment may be initiated earlier and rendered more smoothly and effectively, and patients may be able to recognize the therapeutic effects sooner. In addition, condensing the MMPI to identified key scales consisting of items predictive of negative outcomes may be more useful and help reduce the psychological burden on target patients.

The present study had two purposes : one was to clarify the psychological and biological factors associated with the clinical outcomes of somatoform disorders, and the other was to identify key scales of the MMPI that are predictive of negative outcomes. Towards these goals, we collected data from patients who had undergone assessment using the MMPI in the clinical setting, classified the patients into two groups (improved group vs. non-improved group based on the chart review, and examined these groups. In addition, we also identified the scales of the MMPI that were associated with outcomes and then determined the optimal cut-off values for predicting clinical outcomes by these scales.

Methods

Participants

A total of 125 patients were diagnosed with somatoform disorders based on the ICD-10 at the psychiatric department of Fukushima Medical University Hospital between January 1, 2013 and December 31, 2017[1]. Among them, 67 patients underwent the consultation-liaison psychiatry approach to treatment and 58 patients underwent the psychiatric approach only. In addition, 80 patients were classified as having a persistent somatoform pain disorder, 31 patients as having somatization disorder, eight patients as having an undifferentiated somatoform disorder, four patients as having somatoform autonomic dysfunction, and two patients as having other somatoform disorders. All patients were treated with conventional supportive psychotherapy or pharmacotherapy. The present study was approved by the Ethics Committee of Fukushima Medical University (approval No. 2941).

Measurements and procedures

The MMPI is a standardized and very well-validated psychometric test of adult personality and psychopathology, developed in the 1930s in the United States and reevaluated in the 1980s[25-27]. It is composed of 550 items, and hundreds of additional scales have been developed. The latest Japanese

Version of the MMPI was published in 1993[25,26].

The Japanese version of the MMPI consists of 550 items (566 if duplicates are included in the booklet format). The general target is people aged 15 and over who have a minimum reading comprehension at the level of a primary school graduate. The MMPI results are usually processed numerically, including the calculation of raw scores, and through the aggregation of the essential basic results, which involves 14 basic scales that comprise four validity and 10 clinical scales. After the raw scores are calculated, they are converted into T-scores using the following formula to standardize the raw scores for each scale and to make them comparable[26] :

$$T = 50 + 10 \times (X - M)/SD$$

X represents the raw score for a scale, M represents the mean of the raw scores of the standardized population for that scale, and SD represents the standard deviation of the raw scores of the standardized population for that scale.

The validity scales provide important information about the subject's psychological characteristics, such as distortions of test-taking attitudes. It is important for clinical scales to consider the interrelationships between scale scores to provide a comprehensive profile. The MMPI profile is a graph showing each scale on the horizontal axis and T-scores on the vertical axis. For instance, it is considered that subjects in the neurotic category are more likely to show a downward-to-the-right profile with high scores on the 1st, 2nd, and 3rd scales and low scores on the 6th, 7th, 8th, and 9th scales. Meanwhile, those in the psychotic category are more likely to show an upward-to-the-right profile.

The MMPI can identify the personality of subjects from multiple aspects based on answers to questions assessing, for example, hypochondriac, obsessive, and compulsive tendencies. A parameter for hypochondriasis (Hs) and hysteria (Hy) is a T score of ≥ 70, and when the difference between each of the T-scores of these two scales and the T-score for depression (D) is more than 10 it is called a "conversion V" pattern, which suggests that subjects tend to replace their psychological problems with socially acceptable ones, such as physical complaints. Tendencies to escape from a situation through physical complaints, to try and control others, and to suppress or deny the problem are then presumed[9,10].

Medical records collected from May 1, 2019 to July 31, 2019 were reviewed, and information on factors that might affect the prognosis of somatoform disorders, including age, sex, observation period, comorbidity of developmental disorders, decreased cerebral blood flow, history of surgery, MMPI profile, and presence of the "conversion V" pattern on the MMPI, was obtained. Then, we identified patients with positive or negative outcomes based on data regarding the subjective estimation of (1) pain and (2) social function, including ADLs, obtained from the medical records. Specifically, we determined whether the patient's subjective pain level had changed (improved/unchanged/worsened) and whether the degree of impairment of ADLs or social functioning due to the pain had altered (improved/unchanged/worsened) from the clinician's perspective. While reviewing the medical records, we assessed the changes in the patient's subjective pain level and the degree of impairment of ADLs compared with those at the initiation of the treatment intervention at our hospital from a clinical viewpoint without using any specific assessment tool. For symptoms, we checked the patient's statement about the degree of pain (e.g., better, a little better, unchanged, or worse), and for ADLs, and we checked the patient's statement regarding ADLs such as eating, moving (e.g., walking), toileting, dressing, and changing clothes, in the medical record. Consequently, we classified the patients into the improved group (IG) if either or both parameters improved and into the non-improved group (NIG) if either or both parameters worsened or did not change. There were no patients in whom one parameter improved while the other worsened.

We profiled four validity scales (Cannot say, ? ; Lie, L ; Infrequency, F ; Defensiveness, K ; Table 1) and 10 clinical scales (Hypochondriasis, Hs ; Depression, D ; Hysteria, Hy ; Psychopathic deviance, Pd ; Masculinity-femininity, Mf ; Paranoia, Pa ; Psychasthenia, Pt ; Schizophrenia, Sc ; Hypomania, Ma ; Social introversion, Si ; Table 2) as basic scales of the MMPI[9,28]. The interpretation of the "conversion V" pattern is shown in Table 3. Decreased cerebral blood flow was confirmed when a radiologist reported that "there was low blood flow (Vd less than 30 mL/mL by ARG method)" based on N-isopropyl-(^{123}I) *p*-iodoamphetamine computed tomography, regardless of the brain region. The comorbidity of developmental disorders was confirmed when a psychiatrist noted autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), or pervasive developmental disorder in a patient's medical records. A history of surgery was confirmed if any descriptions of orthopedic surgery were noted in the patient's medical records.

Table 1. Interpretation of the validity scales

Scale and abbreviation	Scale name	Interpretation of score
?	Undefined	A tally of omitted items. High scores may be due to obsessiveness, defensiveness, difficulty in reading, confusion, hostility, or paranoia. More than 10 left unanswered may be of clinical significance. Twenty or more left unanswered should be considered significant.
L	Lie	Tendency to create a favorable impression as a response bias, conventional, rigid, moralistic, repression, denial, and lack of insight. A high L can mean anything from a very well-mannered normal wanting to give a good impression, to a compensated paranoid. A high L will submerge scales of obvious psychopathology and inflate scales of healthy functioning such as the Ego Strength scale. Low : (< Raw 3). Admitting to minor faults and shortcomings, independent, self-reliant.
F	Infrequency	Very high (> T99) possible random, exaggerated, or mis-scored profile. Very high scores (T > 90) commonly found with psychotic patients. High scores (> T70), best measure of overall psychopathology, resentment, acting out, moodiness. Mostly elevations in the F scale are due to psychopathology ; high item overlap with scale 8. Low scores (T < 45), possible fake good profile.
K	Defensiveness	If there are signs of psychopathology in the history, then high K indicates defensiveness, intolerance, dogmatism, lack of insight, and controlling behavior. Very high scores are usually a sign of defensiveness. High scores are common in individuals who are well adjusted and well educated and tend to be in control of their lives. Low (< T46). Guarded prognosis for any insight therapy since their ego strength is low ; masochistic confessors, poor self-concept, distrustful, and angry. A very low K could often be the only indication of psychopathology in an MMPI profile.

MMPI, Minnesota Multiphasic Personality Inventory.

Table 2. Interpretation of the clinical scales

Scale and abbreviation	Scale name	Interpretation of an elevated score
Hs	Hypochondriasis	Excessive preoccupation with the body and physical symptoms
D	Depression	Sadness, discomfort, and dissatisfaction with life
Hy	Hysteria	Feeling overwhelmed by stress
Pd	Psychopathic deviance	Rebellion, difficulty adhering to standards of society
Mf	Masculinity-femininity	Lack of stereotypic masculine interests (in men ; high scores are rare among women)
Pa	Paranoia	Excessive sensitivity, hostility, and suspiciousness (very high scores indicate psychotic behavior)
Pt	Psychasthenia	Anxiety, tension, worry, and obsessive-compulsive disorder tend to score high
Sc	Schizophrenia	Confusion, disorganization, unusual thought processes
Ma	Hypomania	High energy and agitation, overactivity, unrealistic self-appraisal, and mania
Si	Social introversion	Shy, insecure, timid, and introverted

Statistical analysis

We descriptively compared each factor between the IG and NIG. Differences between groups were analyzed using the Mann-Whitney U test, Student's *t*-test, and chi-squared test. Among the MMPI scales, those that showed a significant difference between the IG and NIG on receiver operating characteristic (ROC) curves were created for the Hy scale. The area under the curve (AUC) and 95% confidence intervals (CIs) were calculated, and the cutoff value was calculated using Youden's index. The obtained cutoff values were compared with conventionally used ones. All statistical analyses were performed using SPSS ver. 26 (SPSS, Chicago, IL, USA), and p values < 0.05 were considered statistically significant.

Table 3. Interpretation of the conversion V pattern

Condition	Description
The Hs and Hy scales are T = 70 or more, and are T = 10 or more higher than the D scale.	This suggests that patients tend to "replace" their psychological problems with socially acceptable ones, such as physical complaints, including a tendency to escape from situations set by physical complaints or to control others. It is presumed that the problem is suppressed or denied.

Table 4. Basic characteristics of all participants (comparison by prognosis)

	Improved $n = 46$	Non-improved $n = 79$	p
Age (years)	49.3 ± 17.8	53.8 ± 17.5	0.167
Sex			
Male	16 (34.8)	33 (41.8)	0.440
Female	30 (65.2)	46 (58.2)	
observation period (months)	35 (24-91)	54 (24-120)	0.168
Comorbidity of developmental disorders			
Yes	5 (10.9)	20 (25.3)	0.051
No	41 (89.1)	59 (74.7)	
Decreased cerebral blood flow			
Yes	14 (51.9)	30 (57.7)	0.620
No	13 (48.1)	22 (42.3)	
Conversion V			
Yes	8 (17.4)	14 (17.7)	0.963
No	38 (82.6)	65 (82.3)	
History of surgery			
Yes	15 (32.6)	26 (32.9)	0.972
No	31 (67.4)	53 (67.1)	
Treatment approach			
Liaison psychiatry	23 (34.3)	44 (65.7)	0.538
Only psychiatric	23 (39.7)	35 (60.3)	

Values are expressed as mean ± standard deviation, median (25th-75th percentile), n (%).
Data for decreased cerebral blood flow were missing for 46 cases.
No significant differences in age, gender, duration of illness, the comorbidity of developmental disorders, decreased cerebral blood flow, history of surgery, or the conversion V pattern were found between the improved (IG) and non-improved groups (NIG). Regarding the presence of developmental disorders, the comorbidity rates of developmental disorders were 10.9% in the IG and 25.3% in the NIG. Although this difference was not significant, the rate in the NIG tended to be higher than that in the IG ($p = 0.051$).

Results

Prognostic comparison of the basic characteristics of the participants

In total, 125 patients (49 men, 76 women ; mean age ± SD, 51.9 ± 17.4 years) participated in this study (Table 4). There were no significant differences in age, sex, observation period, presence of developmental disorders, decreased cerebral blood flow, or history of surgery between the IG and NIG. Regarding the presence of developmental disorders, the comorbidity rates tended to be higher in the NIG than in the IG, but this difference was not significant (10.9% vs. 25.3%, $p = 0.051$).

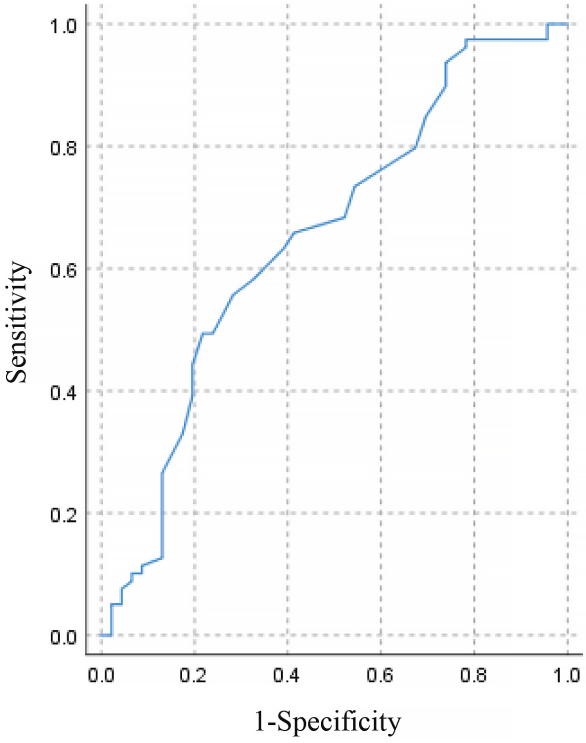
Prognostic comparison of each MMPI scale

Regarding the results of the Student's t-test for each scale of the MMPI, the NIG showed a significantly higher value than those of the IG on the Hy scale (IG, 66.2 ± 15.4 vs. NIG, 73.5 ± 12.4 ; $p = 0.04$). The scores on the ? scale were 45.4 ± 11.1 for the IG and 49.0 ± 9.3 for the NIG ; although the IG tended to have lower scores than those of the NIG, the difference was not significant ($p = 0.051$) (Table 5).

Table 5. Prognostic comparison of each Minnesota Multiphasic Personality Inventory (MMPI) scale

	Improved (n = 46)	Non-improved (n = 79)	p
?	45.4 ± 11.1	49.0 ± 9.3	0.051
L	54.1 ± 13.2	55.2 ± 11.4	0.615
F	55.8 ± 17.8	59.2 ± 17.8	0.308
K	51.2 ± 11.5	53.8 ± 12.4	0.235
Hs	58.6 ± 19.6	63.8 ± 18.0	0.137
D	66.1 ± 14.8	70.9 ± 16.6	0.105
Hy	66.2 ± 15.4	73.5 ± 12.4	0.004*
Pd	53.8 ± 15.3	55.1 ± 15.3	0.661
Mf	49.5 ± 11.8	49.1 ± 12.6	0.859
Pa	55.9 ± 15.8	60.9 ± 15.5	0.087
Pt	47.9 ± 22.3	47.2 ± 25.8	0.875
Sc	47.9 ± 23.4	50.8 ± 26.0	0.528
Ma	46.7 ± 14.6	46.0 ± 11.5	0.769
Si	54.2 ± 13.3	52.7 ± 12.3	0.525

As a result of a Student's t-test for each scale of the MMPI, the non-improved group (NIG) showed a significantly higher value than the improved group (IG) on the Hy scale (IG : 66.2 ± 15.4 vs. NIG : 73.5 ± 12.4 ; p = 0.04). The ? scale scores were 45.4 ± 11.1 in the IG and 49.0 ± 9.3 in the NIG, which were not significant, but the IG tended to have lower scores (p = 0.051).



AUC (95% confidence interval)	p	Cutoff value
0.652 (0.55–0.753)	0.004	73.5

Fig. 1. Receiver operating characteristic (ROC) curves of the Hysteria (Hy) scale scores on the Minnesota Multiphasic Personality Inventory (MMPI) of all participants. ROC analysis performed using the Hy scale scores of all participants showed a significant difference between the improved and no-improvement groups ; at a cutoff value of 73.5 determined based on the Youden index, the area under the curve (AUC) (95% confidence interval) was 0.652 (0.55–0.753).

ROC analysis of the Hy scores of all participants

The results of the ROC analysis performed using the Hy scores of all participants indicated a significant difference between the IG and NIG, with an AUC (95% CI) of 0.652 (0.55–0.753) (Figure 1). The cutoff point was 73.5 with a sensitivity of 55.7% and a specificity of 71.7%. Using a T-score cutoff of 70, the common cutoff value for abnormally high MMPI scales, the sensitivity and specificity were 65.8% and 58.7%, respectively.

Discussion

The present study examined the prognosis of somatoform disorders predicted using the MMPI and found significantly higher scores in the NIG than in the IG, but only in the Hy scale. ROC analysis of the Hy scale scores of the IG and NIG was then conducted to calculate a cutoff value. The cutoff point was 73.5, with a sensitivity of 55.7% and a specificity of 71.7%. The results are discussed in detail below.

Comparison between the improved and non-improved group prognosis groups

We selected basic characteristics such as age, sex, observation period, comorbidity of developmental disorders, decreased cerebral blood flow, history of surgery, and the "conversion V" pattern on the MMPI as factors that might affect the outcomes of somatoform disorders. An analysis of each outcome group did not reveal any significant differences. While cerebral blood flow was found to be decreased in patients with chronic pain[29], no significant differences were found in the current study. Meanwhile, participants in the NIG were more likely to have developmental disorders. Among developmental disorders in children, both ASD and ADHD are associated with a high rate of chronic pain[30,31], from which therapeutic benefit can be obtained by combining psychosocial treatment with pharmacotherapy[32,33]. Therefore, when patients have a developmental disorder as a comorbidity, targeting

their developmental disorder with a therapeutic intervention could improve the somatoform disorder.

Significance of high scores on the Hy scale

A high score on the Hy scale indicates a tendency to avoid responsibilities related to psychological conflicts by converting these to physical symptoms (a tendency to use conversion symptoms). It also means that individuals tend to be immature and lack self-insight, indicating that their relationships with other people are often superficial, even though they may appear to be socially well-adapted[9]. A significant difference was observed between the IG and NIG only in the Hy scale score. Therefore, ROC analysis was performed on the Hy score for the IG and NIG, and a cutoff score of 73.5 was established. Previous studies have reported that patients with chronic pain show higher Hy scores[34,35].

When K and Hs scale scores are low, a high Hy scale score is insufficient to establish that the pain is psychogenic[36,37]. Despite this, a high Hy score is still considered to indicate a remarkably severe degree of distress in terms of physical symptoms. Few reports have been published on the outcome viewpoint of the MMPI for somatoform disorders, and no reported cases have shown meaningful profiles or characteristics for each scale[38]. The cutoff point calculated in the present study was 73.5, which was higher than the score generally considered to be abnormal in each MMPI scale, including the Hy scale (T-score $\geq$ 70).

In the present study, the specificity (71.7%) value obtained using the cutoff value of 73.5 is much higher than that (58.7%) calculated using a cutoff value of 70 on the Hy scale. A test with high specificity is useful for confirming a disease when the result is positive. Thus, we should be able to more efficiently identify patients with somatoform disorders who will respond poorly to conventional treatment. That is, patients with somatoform disorders with a Hy scale score higher than this cutoff value will be considered difficult to treat with conventional supportive psychotherapy or pharmacotherapy. In these patients, it may be necessary to consider multidisciplinary psychiatric treatment, which is a further enhancement of conventional treatments[39-43], e.g., psychosocial treatments such as cognitive behavioral therapy[44-48] or mindfulness therapy[49], pharmacotherapy, and environmental adjustments. Therefore, this cutoff point appears to be an important index for treatment selection in patients with somatoform disorders.

Interestingly, Pearson's chi-square test of liaison cases and cases treated using only the psychiatric approach at our hospital, grouped by Hy > 73.5, showed a significantly larger number of liaison cases than expected ($p = 0.05$). In other words, the proportion of patients with Hy > 73.5 was higher in the liaison group than in the other group. On the other hand, no significant difference was found when comparing the outcomes of consultation-liaison psychiatry cases and cases treated using only the psychiatric approach, suggesting that the liaison approach was more effective in treatment-resistant cases. However, if the Hy scale score exceeds the cutoff point, prospective studies are needed to compare the prognoses between patients undergoing therapeutic interventions such as augmented pharmacotherapy and psychotherapy, psychosocial treatment, and environmental adjustments and patients who receive standard therapy (general pharmacotherapy and supportive psychotherapy).

Limitations

The present study has several limitations. First, the classification of the outcomes of somatoform disorders in the study groups was based on medical records only and did not consider more reliable methods such as diagnostic (structured) interviews or self-administered questionnaires. Second, the MMPI assessment was often performed within one month of the first visit to the hospital for consultation liaison-psychiatry cases and within several months of the first visit for patients treated using only the psychiatric approach. However, the timing of the assessment was not constant because the assessments were performed in the real clinical world. Lastly, the pain level experienced by participants and their functional capability with ADLs was assessed by the researcher from a clinical viewpoint only, and no specific assessment tool was used. Therefore, we recommend that patients' pain levels, ADL capability, and outcomes are classified, compared, and analyzed using reliable assessment tools in the future.

Conclusions

The Hy scale score in the MMPI was found to be a significant influencing factor of prognosis in patients with somatoform disorders. Specifically, patients with a score above 73.5 responded poorly to conventional supportive psychotherapy or pharmacotherapy. Therefore, this cutoff point may be used as an important index in treatment decision-making for improving the prognosis of patients with somatoform disorders.

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Conflicts of interest

The authors have no competing interests to report.

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